The Welding Engineer

Founded by L. B. Mackenzie, 1916

JULY, 1926 VOL. 11, No. 7

$3.00 per year in U. S. 608 S. Dearborn St., Chicago, Ill. Reg. U. S. Pat. Office $4.00 per year abroad

You can be assured of High Purity Oxygen for Metal Cutting by specifying the purity in your oxygen contract.

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Airco-Davis-Bournonville Oxyacetylene
Welding and Cutting Apparatus and Supplies

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Published monthly by the Welding Engineer Publishing Co. Entered as second class matter Jan. 20, 1916, at the Post Office at Chicago, Ill. Under the Act of March 3, 1897.

Welding rods may look alike

but – To the naked eye, welding rods look alike and without a microscope you could not distinguish between them.

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for Electric Welding

This new wire is of extremely low carbon and manganese content, with all impurities and gases held to an absolute minimum.

It is equal in every respect to Norwegian or Swedish Imported Wire and far superior to the usual Mild Steel Rod. The elements which gave so much trouble in the latter are entirely eliminated.

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Samples for test purposes will gladly be furnished on request, and inquiries are solicited from distributors and larger users.

REID-AVERY COMPANY, INC.

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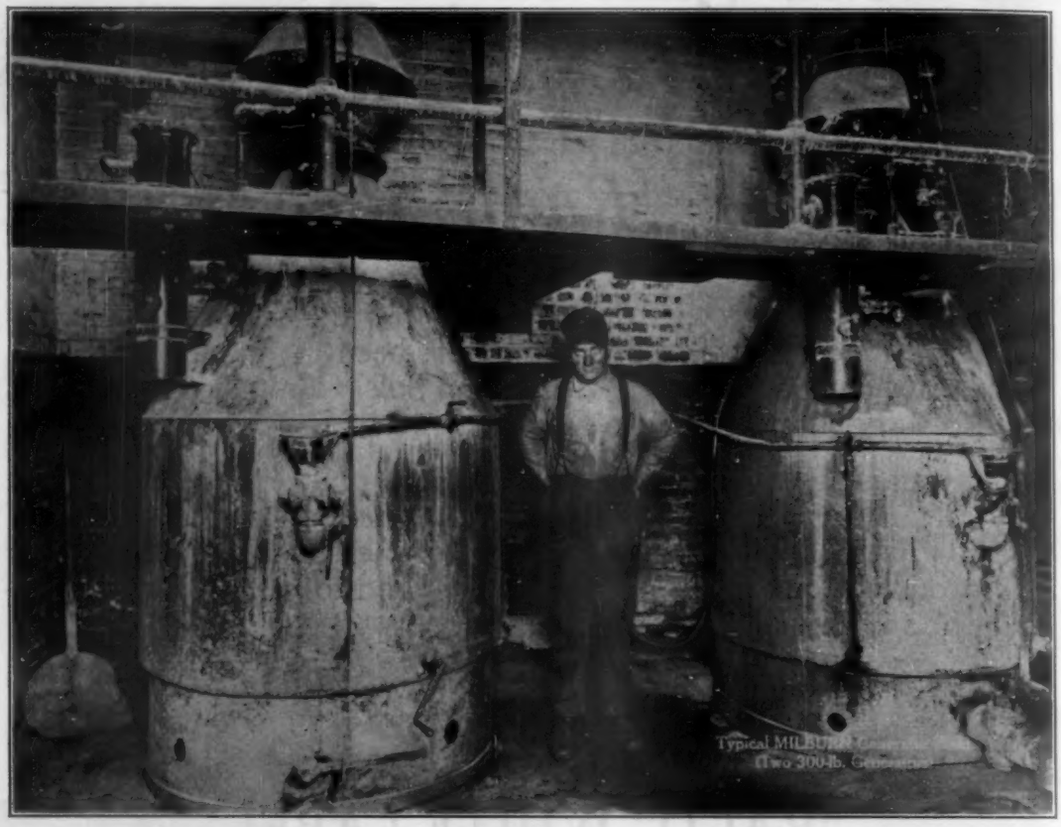

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WORLD'S BEST
MILBURN
ESTABLISHED 1907

The Welding Engineer

Founded by L. B. Mackenzie, 1916 — Reg. U. S. Pat. Office

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You Meet The Leaders Here

IT is the salesman who brings new ideas and new suggestions for more profitable operation who usually gets the best attention. You know that buying his goods is a profitable investment, regardless of slight differences in price. As a general rule you will find that he represents the most progressive type of manufacturer. This type of manufacturer develops not only high grade products but also useful processes. The development work is made known to you as a consumer through the advertising pages of this paper. You can safely depend upon their announcements to keep you thoroughly posted every month on important welding developments. These advertisements contain many messages that you cannot well afford to miss.

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Last Advertising forms close at 8:00 a. m. on the 12th. To show proof for correction copy must be received at an earlier date and allowances should be made for delay to mails. All copy should be in by the 12th of the month at the latest.

The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

Authorized Representatives

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SOUTH AFRICA—J. W. Arnison, 25a Victoria Ave., Benoni, Transvaal, South Africa.

Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

ACETYLENE (Compressed in Cylinders)
Air Reduction Sales Co.
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International Oxygen Co.
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See "Cutting Electrodes"

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Lincoln Steel Co.
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Reid-Avery Co.
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Seneca Wire & Mfg. Co.
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FLUE WELDERS (Electric)
General Electric Co.

FLUXES
Air Reduction Sales Co.
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Oxweld Acetylene Co.

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Safety Equipment Service Co.
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HELMETS (Arc Welding)
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Burke Electric Co.
Electric Arc Cutting & Welding Co.
Fibre-Metal Products Co.
General Electric Co.
C. H. Hollup Corp.
Ideal Face Shield Co.
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Safety Equipment Service Co.
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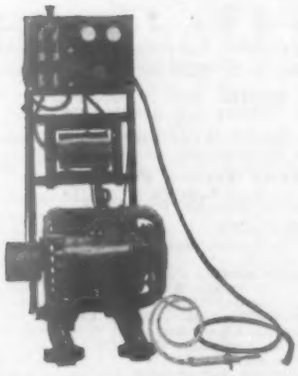
Strauss & Buegeleisen
Sutton-Garten Co.
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.

Select the Wilson Welding Machine that Meets Your Own Operating Conditions

Wilson Type S Single-Operator Motor-Driven Electric Welding Machine. Designed for both production and repair work. Adapted for use wherever power is available. Capacity, 25 to 250 amperes.



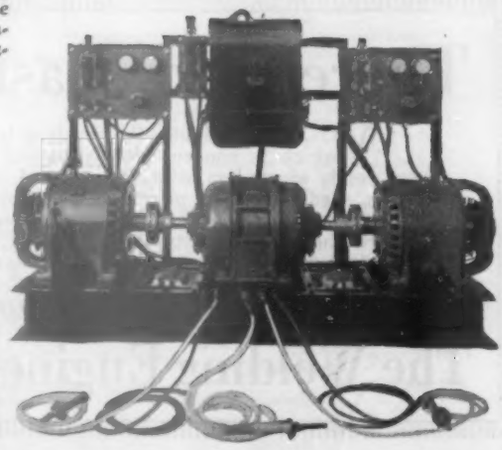
Wilson Type S Single-Operator Belt-Driven Electric Welding Machine. Belt-driven from line or counter shaft or for direct connection to gasoline engine. Capacity, 25 to 250 amperes.

Wilson Type S Single-Operator Gasoline-Engine-Driven Electric Welding Machine. A complete, self-contained unit—may be easily moved and operated anywhere. Capacity, 25 to 200 amperes.

Wilson Type S Single-Operator Gasoline-Engine-Driven Electric Welding Machine, heavy duty type. Capacity, 25 to 250 amperes.

Type S Features

Every Wilson Type S machine has a simple, compact control panel; a *self-exciting* generator; an arc that is easy to strike and easy to maintain; a current adjustment by a simple turning of a field rheostat knob; a commutator that always shows *less temperature rise than any other part of the machine.* The welding current can be reduced to as low as 25 amperes for welding thin-gauge metals.



Wilson Type S Two-Operator Stationery Motor-Driven Electric Welding Machine, heavy duty type. Capacity, 25 to 500 amperes.

With its simple construction, close regulation, rugged strength—*superior engineering throughout*—the Wilson Type S has proved itself a *better welding machine.* Its features—many of which are found in no other machine—make the Wilson Type S the choice for practically every kind of welding. And you can select the Wilson welding machine that meets your own operating conditions. Read descriptions above, and write today for full information and prices.

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Oxweld Acetylene Co.
Torchweld Equipment Co.

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Torchweld Equipment Co.

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Milburn, Alexander, Co.
Oxweld Acetylene Co.
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OXYGEN
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Wodack Electric Tool Corp.

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Torchweld Equipment Co.

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Oxweld Acetylene Co.
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Oxweld Acetylene Co.
Sutton-Garten Co.
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The Welding Engineer 608 S. Dearborn St., Chicago

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WORLD'S BEST QUALITY—HIGHEST GAS YIELD

ALWAYS PACKED IN BLUE AND GRAY DRUMS

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Quincy....313 Delaware St.
Rockford....220 Prairie St.
Springfield....1000 E. Monroe St.
Streator....501 E. Hickory St.

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Evansville....1401 E. Illinois St.
Fort Wayne....2206 Broadway
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South Bend....412 East Tutt St.
Terre Haute....541 N. Fifth St.

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Davenport....118 Harrison St.
Des Moines....Third and Elm Sts.
Dubuque....Eighth and Washington Sts.
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Sioux City....416 Court St., P. O. Box 398
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Grand Island....311 West 4th St.
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Enid....Chestnut and Adam Sts.
McAlester....31-37 East Chickasaw St.
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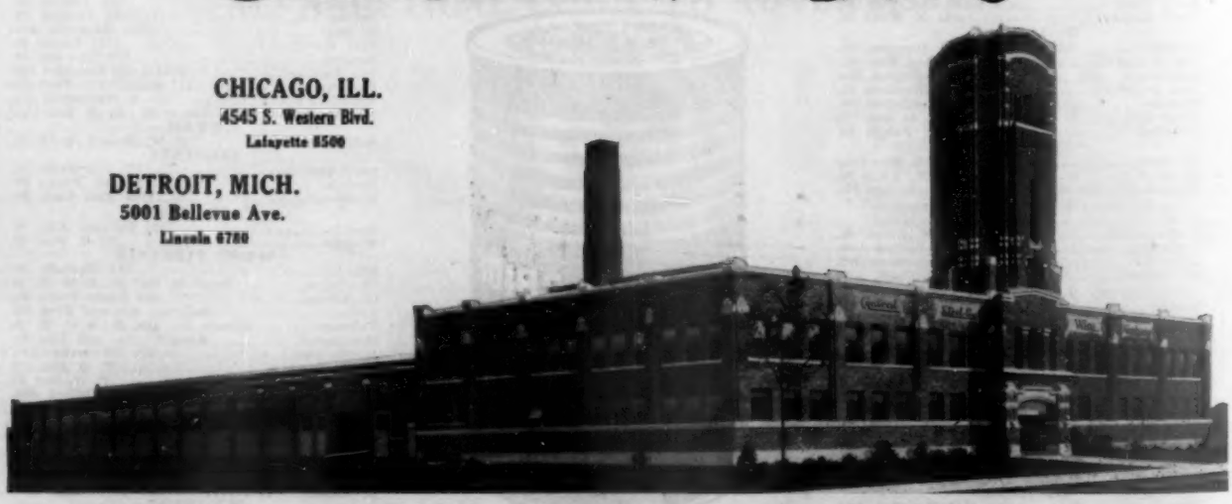

Main Warehouses and General Offices, Central Steel & Wire Co., Chicago.

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After 8 Years

He states;

"From what I have heard from other operators I feel perfectly satisfied with the Lincoln. They give steady voltage and long service."

See letter below

Galion, Ohio.
Dec. 29. 1925.

The Lincoln Electric Co.
Cleveland Ohio.

Gentlemen:

In reply to your letter of some time ago I am pleased to state that I have operated the Lincoln welder since November 1918 and have operated them steady ever since. I have never used any other type of machine than the Lincoln welders and from what I have heard from other operators I feel perfectly satisfied with the Lincoln. As they give steady voltage and long service. I am employed as a welding foreman by the National Grave Vault Company, Galion Ohio

Very sincerely yours
Mr C. W. Ott.
Galion Ohio.
258 Orange St.

The Lincoln Electric Co., Cleveland, Ohio

The Welder's Guide

In Using Elecweld Special

The "Sound of the Arc" test is a valuable test which can be applied to a weld without the use of mechanical apparatus.

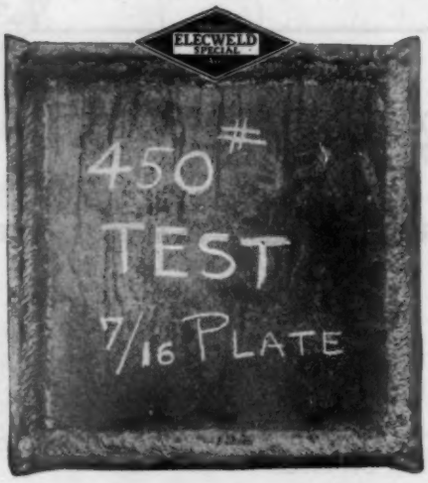
Under a normal degree of current strength, a slow irregular snapping sound denotes a long arc or a poor flowing rod, both undesirable. However, a longer arc is required when using a poor flowing rod as the rod flows in larger globules, requiring greater clearance, and produces a hissing sound developed only as the globule forms at the end of the rod before passing through the arc.

The combination of a very short arc and a poor electrode has a tendency to produce sticking because there is not sufficient space for the large globule to pass through the arc.

The uniform rapid fire-cracking or clicking sound denotes a good flowing quality and proper length of arc.

Try ELECWELD SPECIAL
and note the result

A Practical Book on Welding
Send for Your Copy



Resisting High Pressure

With "Elecweld Special" Welds

THE above test box welded with Elecweld Special Rods, and having no Stay Bolts, was subjected to 450 lbs. Hydrostatic pressure per square inch before any leaks developed. The box was 13½" x 13½", having a 2¾" water space; the walls were $^{7}/_{16}$" fire box steel, used for heating boilers, made by the Frost Manufacturing Company, Galesburg, Ill.

Elecweld Special, a bare rod (flux coated when specified), very low in carbon, phosporus and sulphur, contains no gas forming impurities to cause pockets and pinholes, is unusually uniform in its flow through the arc and produces a smooth, clean, close grained weld.

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In Acetylene and Electric Welding

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Norweld . . . . . A	High Manganese A & E	Steelweld . . . . . E
Castweld . . . . A	Nickelweld . . . A & E	Wilson Color-tipt . E
Bronzeweld . . . A	Elecweld Special E	Vanadweld . . . . . E

*Acetylene—†Electric

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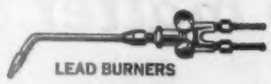
WELDERS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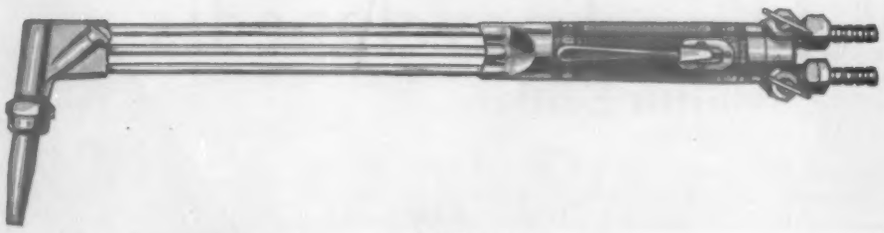
REGULATORS

SPECIAL BURNERS



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Has no equal when using Hydrogen or City Gas with Oxygen—will also function on Acetylene.

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"The Most Complete Line in America"

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With which is now merged the U. S. Welding Co., formerly of Minneapolis, Minn.

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No matter what kind of welding you do--

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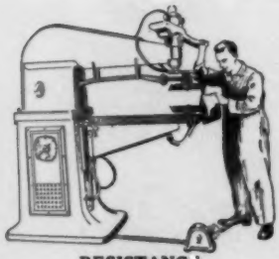
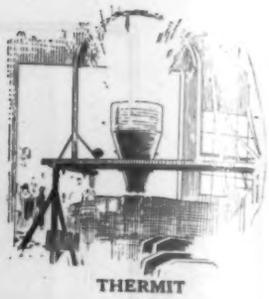


RESISTANCE



THERMIT

If you Weld, you need this book

The Welding Encyclopedia

Fifth Edition

Price

$5.00

479 Pages, 625 Illustrations. Flexible Leather Grain Binding.

It describes in detail the theory and practice of every welding process. It tells how to weld every weldable metal by each of the welding processes. It gives detailed instructions for handling the important welding jobs, such as boiler welding, sheet metal welding, tank welding, pipe welding, etc. It tells how to prepare parts for welding. It tells how to install and care for welding equipment. It explains the meaning of all words and terms found in welding literature. It tells where to buy all standard makes of welding apparatus and supplies.

Contents

1. Illustrated encyclopedia covering all words, terms, and trade names used in welding.

2. Oxy-Acetylene Welding.—Aluminum, Steel, Cast Iron, Brass, Bronze. (Full instructions for welding each of these metals.)

3. Electric Arc Welding.—Complete instructions for welding all metals, studding, cutting, etc.

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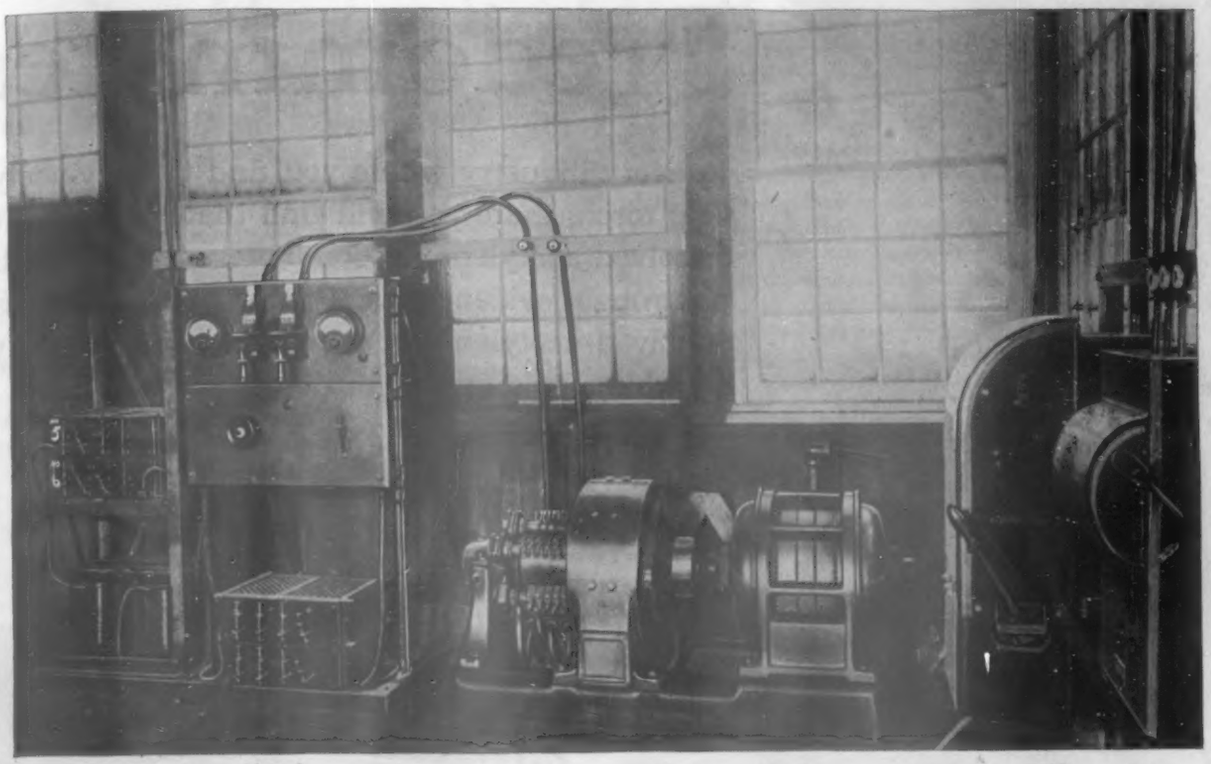

Arc Weld!

4 welders work from this one machine. It is a G-E Constant Potential welding set installed at the plant of the Coshocton Iron Co., Monongahela, Pa. If this set were not used, 4 individual welding sets would have to be purchased; 4 individual welding sets would have to be maintained.

G-E Constant Potential sets are compact, highly efficient "central stations" for welding on a large scale. They save the price of a large number of individual welders. Because there are fewer brushes, fewer bearings, and fewer rotating parts, their maintenance is far less than that of the welders they replace. Investigate these multiple-operator welders whenever you plan quantity welding.

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General Electric furnishes to the Welding Industry:

- WD Arc Welders—designed for one operator
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Bulletins on every type available at your nearest G-E office.

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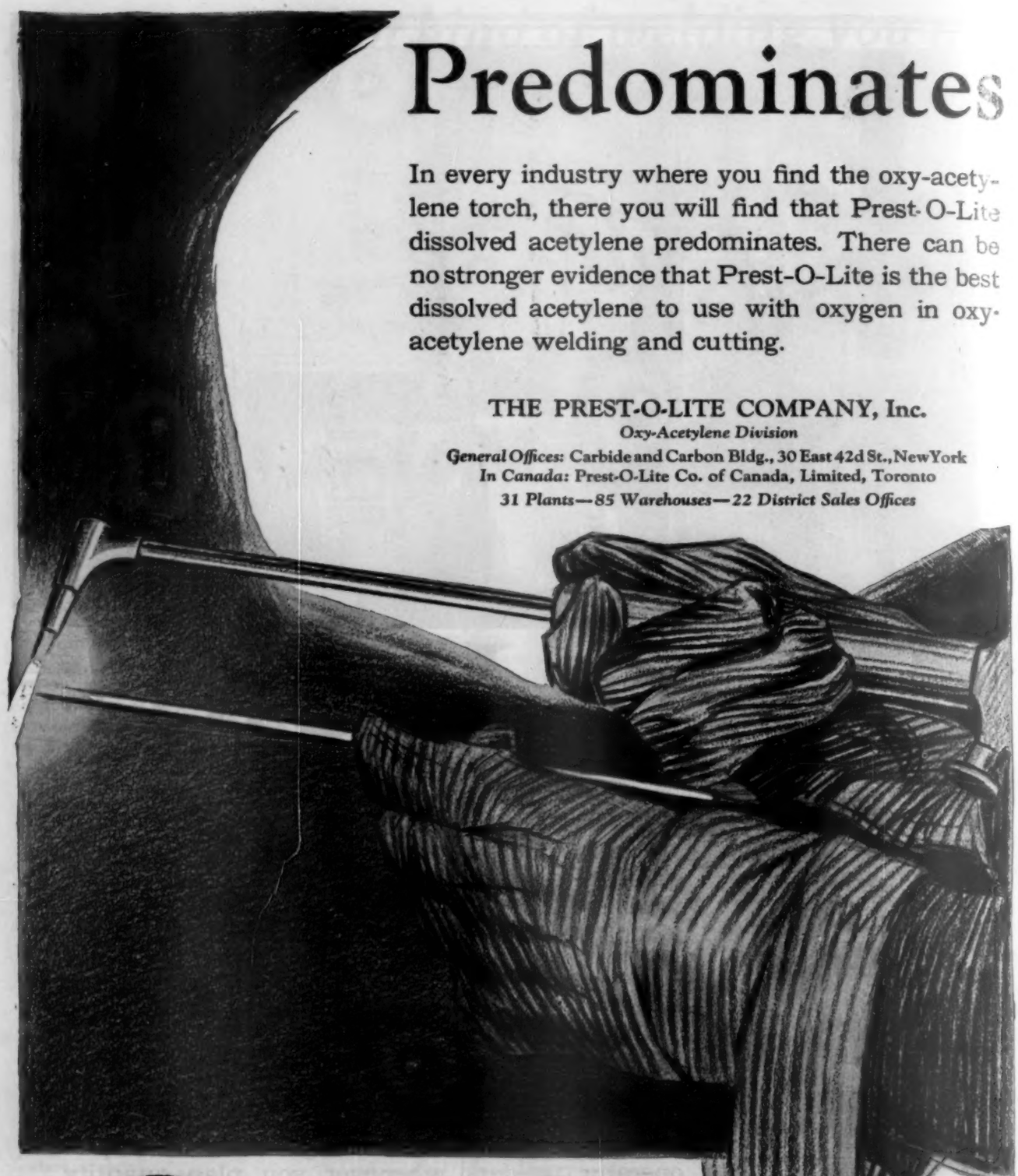

Predominates

In every industry where you find the oxy-acetylene torch, there you will find that Prest-O-Lite dissolved acetylene predominates. There can be no stronger evidence that Prest-O-Lite is the best dissolved acetylene to use with oxygen in oxy-acetylene welding and cutting.

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EDITORIAL

Looking Forward to "School Days"

VACATION time offers excellent opportunity to make progress with plans for improving the educational work which is being done in and for the industry. Very few of the trade schools continue their courses through the summer and instructors will take a more favorable view of suggestions for changes in their work if such suggestions are presented at a time when they are not swamped with the details of their regular routine. Welding instruction has shown a marked improvement during the past two or three years and the men who are teaching future operators continue to show a greater appreciation of the importance of the process and a greater desire to furnish industrial plants with men who are properly equipped for their work as welders. There is one general principle which should be brought to the attention of every welding instructor individually, to the end that he may impress it upon all students coming to him in the future for instruction; that is the principle which has been given the name of procedure control. The men who are to take up the study of the process during the coming year will not, of course, be engineers, but it will do no harm and certainly should be productive of very much benefit to have these men understand that the process should always be applied in accordance with sound engineering principles; equipped with the knowledge that the material to be welded, the filler rod and the design of the joint should all be selected with a view to making welding both easier and better; that different kinds of welding require different methods of procedure; that a welder who has been trained for one particular kind of work needs additional instruction before being assigned to a new application of the process; and that systematic testing of the finished work is necessary to insure satisfactory results. Many operators would then be on the lookout for these fundamental things and be inclined to insist upon conditions which make for the best workmanship. To instruct men in the principle of procedure control does not require any appreciable amount of extra work on the part of the instructor, certainly not in comparison to the amount of good which would be accomplished by persuading every instructor to give the subject the proper amount of time and thought. Before the fall terms of the different trade schools get into operation the instructors will have a certain amount of time to devote to a leisurely consideration of things that might be done to make their courses more valuable to the students. It seems reasonable that suggestions along this line can be made at this time, with the expectation that they will bear fruit in the years to come. It is never going to be desirable to be thoroughly satisfied with the educational program.

Fundamental Principles Affect All Departments

AN ANALYSIS of the work of the National Safety Council contained in a recent address by one of the executives of the Council, contains among other things a few reasons given for increases which have been noted in the frequency and severity of accidents reported in a few industries. Speeding up production, necessity for cheaper production with less attention given to safety, increased labor turn-over, and too much attention to safety education with not enough to the problem of safeguarding new equipment, are the main reasons given for statistics which show increases, where there should have been decreases. Very few words in this list of reasons would have to be changed to furnish the explanations for most of the cases where the use of welding has resulted in disappointment or failure. It is plain enough that some principles of operation are fundamentally wrong. If such principles are applied in practice the results are certain disappointment. If these principles are allowed to operate in one department only, it is probable that only the work of that department will suffer, although it is impossible to keep the effect from being felt upon the entire organization. The first three reasons given for increases in accident records are identical with the reasons which have caused most of the grief in welding . The industry is now working hard to influence all users of welding in the opposite direction, warning them against the things which cause failures and urging methods which result in perfect satisfaction with the process. Two principles of successful operation are receiving particularly keen attention. The first is that production speed should not be carried above the point which makes possible high grade workmanship; the second is that good operators kept on the payroll at a rate which keeps them contented and interested in the work are a good investment . Then, where ever possible, plant executives are being persuaded to put welding under competent engineering supervision so that all the welding operations will be conducted under a definite and systematic plan. Where industries have given attention to the principles which have been worked out by safety engineers, a reduction in accidents has resulted and in some industries the savings which have resulted have been enormous. Similar parallels have been found in the development of welding and it is certain that by following the right principles the users of welding can assure themselves of continued satisfaction with the results.

Sheet Steel Products Make Work for Welders

SO GREAT is the influence of the welding process on the possibility of extending the market for pressed steel articles that one writer in the monthly bulletin of the Sheet Steel Trade Extension Committee suggests that in place of pressed steel it might be better to say welded pressed steel, because pressed steel is rarely found in use without some form of welding. The processes are spoken of as being of the utmost importance in a great increase in the use of pressed steel. This generous boost for the welding industry was just one interesting item in a good sized bulletin featuring the possibilities for new markets for sheet steel products. Certainly there are few things which would be better for the welders than an increased demand for such products. Nearly all of them demand some form of welding in the production program. Finding and suggesting new uses for such products is therefore one more method that can be used to make more work for welders and more orders for apparatus and supply manufacturers.

Mr. Ellis' Paper

IN MR. ELLIS' paper on the subject of scientific supervision of welding can be found what is probably the best expression of opinion which has so far been contributed by an engineer outside of the industry. It is doubtful whether such a splendid statement of the case of welding could have been made by many engineers in the industry itself ten years ago. The processes, their applications, and their problems were not so well understood then as they are now. The industry has made remarkable progress, partly on its merits and partly as the result of vigorous and intelligent publicity work. Mr. Ellis contributes an interesting and accurate summary of the present status of welding. The way to future progress and rapid expansion of the application of welding would be smooth and easy if all engineers had as clear an understanding of welding and its possibilities as the reader will find expressed in the article mentioned.

Is oxygen an investment or merely expense?

IF you buy from Linde you buy not only a product that has been industry's standard for years, but an interest in the oxy-acetylene process that has never failed to pay dividends to the user.

Through Linde field service you will be kept up-to-date in oxy-acetylene progress; you will have practical help and engineering advice when you need it; and through the latest development in Linde service—the Procedure Controls—you will be able to carry out the most difficult welding jobs practically unaided.

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Manufacturers of oxygen, nitrogen, pyrogen, argon and neon
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General Offices: Carbide and Carbon Building
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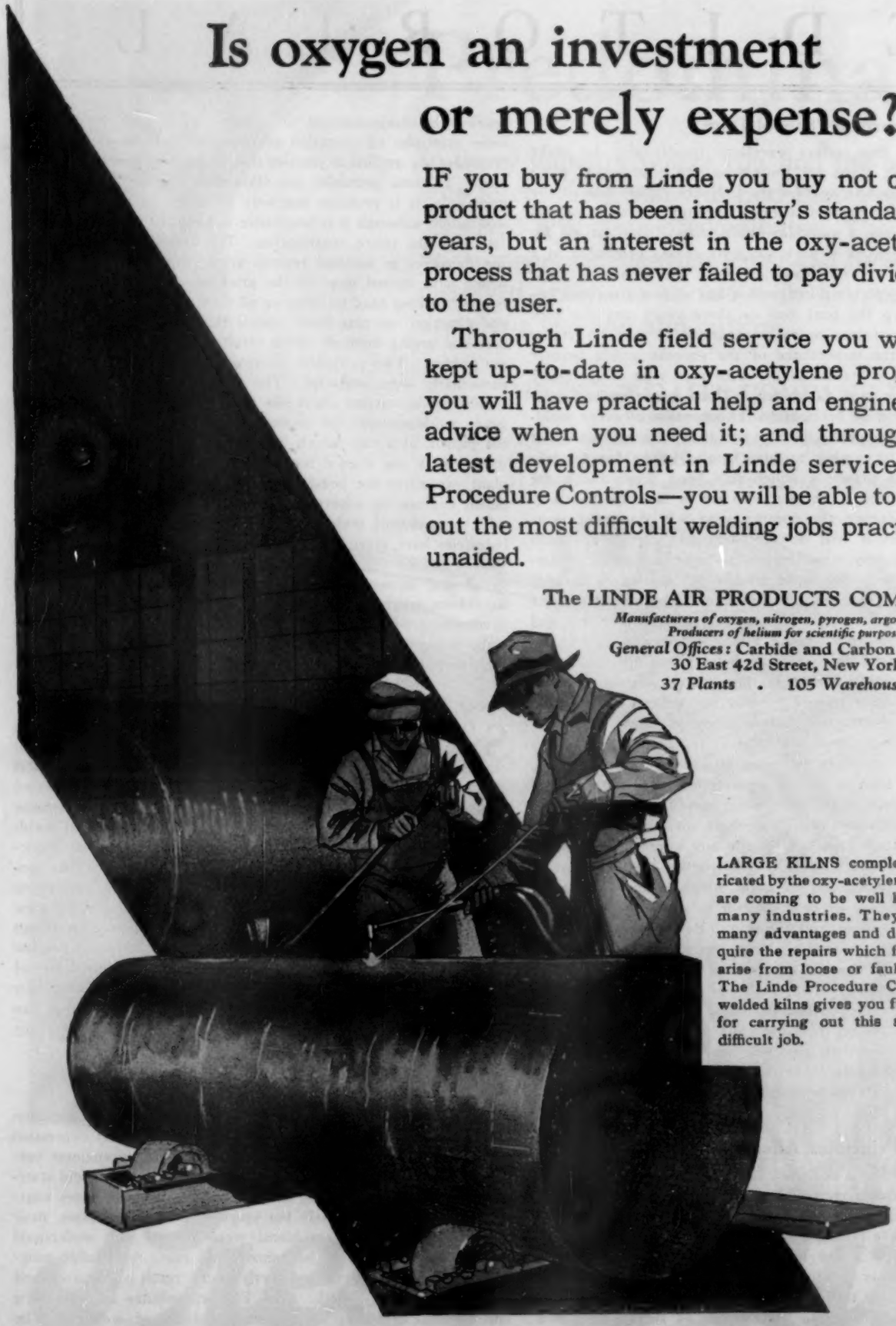
37 *Plants* . 105 *Warehouses*



LARGE KILNS completely fabricated by the oxy-acetylene process are coming to be well known in many industries. They possess many advantages and do not require the repairs which frequently arise from loose or faulty rivets. The Linde Procedure Control on welded kilns gives you full details for carrying out this seemingly difficult job.

LINDE OXYGEN

Scientific Supervision of Welding

Welding Is as Safe and Dependable as Any Other Type of Construction, Provided It Is Properly Controlled

By A. R. Ellis*

THE DAY has come when the engineering fraternity can no longer turn up its nose, so to speak, at the welded structure; and it is surprising how many engineers are still doing that thing. Great progress has been made in the art of welding and in the engineering of welding, and in the design and research for the proper kind of materials to use in welding.

There are some who object to welded structures on the grounds that they cannot tell what is in the weld without destroying it, and for that reason they condemn the process as being too hazardous for engineering design and construction.

The same argument holds good in the case of concrete. One cannot tell what is inside a mass of concrete without destroying it and yet many highly satisfactory concrete structures have been built, and concrete as a structural material has become an important factor.

Ordinary Precautions Avert Failures

Certain precautions are taken in the case of concrete. Cement, sand, and gravel or broken stone are tested. Mixtures are designed as to proportions and water content. Concrete is properly placed and amply protected against temperature variations and it is kept moist while hydrating. Finally cylindrical test specimens are taken during pouring and are later tested for compressive strength. Thus materials and workmanship are carefully selected and supervised, and the quality is proven by ultimate test.

There is no reason why the same procedure cannot be followed in the case of welded structures. It is done today where the buyer or the contractor or both are sufficiently interested in the quality of output to take the necessary precautions to ensure sound, properly welded structures. There is the same possibility of knowing definitely what kind of materials and workmanship are used, and there is the same possibility of determining quality.

To secure a properly welded joint there are three important factors involved: Distortion must be prevented. Complete fusion must be obtained. Thorough penetration must be assured.

Correct Design Prevents Distortion

The prevention of distortion requires proper design of the joint, and it is here where engineering knowledge on the subject will be most effective. Unless the joint is scientifically designed; unless the method of holding is nicely worked out, and unless the correct allowances are made for expansion and contraction; then even though thorough penetration and complete fusion are secured, one is apt to have a joint containing locked-in stresses which may be relieved unexpectedly and cause failure.

Fusion and penetration are part of the welding technique and may be obtained in many ways. Most any of the recommended welding practices go into these features quite thoroughly.

The process of welding therefore is an engineering problem; one that has to be first of all carefully designed; second, skillfully manipulated by trained operators; and third, tested for quality of workmanship.

Assuming the engineering of the welding has been properly worked out, and the proper materials have been selected, the personal equation of the welder will either make the joint a success or a failure. The result of the whole operation may be qualified by his degree of skillfulness.

High Standards of Workmanship Required

It therefore becomes necessary to keep his work up to a very high standard. This can be done by frequent tests of his workmanship both on pieces made specifically for tests and on pieces cut from his ordinary run of work. It has been found that most operators take a great deal of pride in keeping the efficiency of their welds up to a high standard once their interest has been aroused.

There are many ways of testing the efficiency of welded structures. Some of the tests can be made with ordinary tools in a machine shop; others require more elaborate tests; still others require scientific apparatus and highly skilled physicists and chemists.

The simplest test to make is a bending test. This can be done in an ordinary vise with a hammer. Place a section of the welded plate in the vise with the line of weld parallel to the jaws; strike with light blows with a hammer, and bend the plate so that the outer face of the weld is in tension. A good weld should be capable of bending at least 90° without fracture. Frequently it can be bent 180° and reversed.

Welds May Have Strength of Parent Metal

Test specimens may be cut from the finished article or may be cut from sections of plate welded together as test specimens. These may be tested in tension and if the break occurs in the weld the weld should be examined. A good welder using the proper kind of equipment and welding rod should be able to secure a strength in his joint equal to the strength of the original base metal.

If the break occurs in the weld an examination of the broken surface will be interesting. Examination under the magnifying glass may show blow holes, slag or oxide inclusions, and these may be caused by improper materials or careless handling of the welding tools. A fracture between the base metal and the weld may indicate lack of proper penetration between the base metal and the molten metal of the joint or incomplete fusion.

*General Manager, Pittsburgh Testing Laboratory.

Chemical analysis may be made from the metal at the joint to indicate what if any metallurgical changes have been involved in the fluxing process, indicating perhaps the advisability of using a different rod.

Microscopes Give Valuable Information

Sections of the joint can be planed, polished, etched, and examined under the microscope for defects invisible to the naked eye, and for a change in grain structure caused by heat conditions.

The ordinary pocket magnifying glass will sometimes show on a polished, etched section the presence of oxide film which is of course fatal to welding; and the proper remedy is then applied to the operator's technique or to his equipment.

In important welding, and all welding is important, operators should be required to qualify before they are permitted to undertake the work. Proprietors of welding shops who are building a business for the future should be sufficiently interested to require this of their men because their reputation and their future business are in the hands of the operator.

Select Operators Carefully

Buyers of welded articles and engineers using welded structures would do well to see that this requirement is enforced. It is their protection against faulty workmanship.

The last few years have seen some very important, heavy structures and heavy pressure containers turned out in which all of the joints have been made by the welded process, and there are going to be more of them seen.

Like every new process, however, it is necessary for both the buyer and the seller to surround themselves with precautions against faulty workmanship and faulty equipment and to take steps to train workmen in the proper use of materials and equipment handled, and to guard against the human equation which is ever present in all industry.

ARC WELDED PIPE LINE

WHAT is said to be the first all welded water pipe line in this country and the longest pipe line of its type, was recently completed for the city of Vallejo, California. This pipe line has a length of 22 miles and was built for the transmission of water from a new reservoir in the Gorden Valley to the City's Fleming Hill reservoir, just north of Vallejo.

The city of Vallejo is situated in Solano County, California, near the head of San Pablo bay, on the east shore of Mare Island Strait. It has a population of 26,000. The water supply is municipally owned and is secured from storage reservoirs in Wild Horse Valley, about 14 miles northeast of the city.

The growth of the city as well as the increasing demand of the Mare Island navy yard (supplied by the municipal system) made it necessary to increase the water supply materially. As a result, it was decided to develop the Gordon Valley project, involving the creation of a storage reservoir in Gordon Valley at a point about 26 miles northeast of the city, and the installation of a pipe line to the city to connect with the existing municipal distributing system, a total distance of approximately 22 miles.

The pipe line is of steel-plate construction, all seams being electric-arc welded. The pipe is 22 and 24 inches in diameter, 15 miles being 24-inch and 7 miles, 22-inch pipe. Of the 24-inch pipe there are approximately 11 miles having a wall thickness of 3/16 inches and 4 miles of ¼-inch material, whereas, the 22-inch diameter pipe has a wall thickness of 3/16 inches.

The complete pipe line was built by the Western Pipe and Steel Company. The total static head on the pipe varies from 100 to 400 feet, and all of the pipe was tested at the shop to 425 pounds pressure. A number of sections were tested to 325 pounds and a few, to 720 pounds pressure but no leaks developed in the welded seam.

Automatic electric arc welding was used at the factory for making longitudinal seams for 14-foot sections of pipe. Two of these sections were joined together by means of a circular weld using semi-automatic equipment. The 28-foot sections were delivered in the field and several sections were welded together on the surface by hand welding before being lowered into the ditch.

The finished 22 miles of pipe was put under final test for 48 consecutive hours in the early part of March of this year. During this length of time the pipe was held under a press pressure of 200 pounds per square inch at the lowest point in the line, and was found to be absolutely free from leaks. During the 48 hours of test the line was continuously patrolled and inspected at all points but no leakage was discovered.

During the time of filling the line, but one leak occurred in the straight seam, in the entire length. Nineteen girth seams showed leakage or sweats out of a total of 8200 girth seams in the entire length. Of this total, 4100 were field joints, hand welded, and the remaining seams were shop welded with semi-automatic welding equipment. The field welding equipment used consisted of several gas engine driven, General Electric welding generators.

Following the final tests and inspection, the pipe was officially accepted by the city of Vallejo on April 2.

See Photos on Opposite Page

1. Birdseye view of the ditch with some of the pipe in it.
2. Close-up of pipe in ditch running over hill in distance.
3. Ditch with lengths of pipe beside it.
4. Original Fleming Hill reservoir with pipe ready for installation in trench leading to larger reservoir.
5. Lowering 100-foot section of pipe into trench.
6. Two sections of pipe undergoing hydraulic pressure test simultaneously.
7. Ten-ton caterpillar crane with 35-foot boom handling pipe.

WELDING SAVES TIME

If saving of time plus greater strength may be considered as desirable goals in the industrial field, the F. L. Smith Company, Elizabeth, N. J., has found a method of obtaining the desired by substituting welding in place of riveting. It has been their experience that this process is a dependable aid in practically every use to which it has been put in their factory.

For example, in the manufacture of coal feeding screws. Formerly the screw shaft was tapped, a stud inserted and the fin riveted to the stud. This method took thirty-two hours. By using welding, this factory was enabled to join the fins directly to the shaft and thereby reduce labor hours to eight. Additional strength was developed at the same time by welding the joints formed between each two consecutive fins. Production welding is done with Lincoln Electric Company machines on guard casings and other similar products composed of light angles and plates. Welding makes a vibration proof connection, it has been found.

As a maintenance process, electric welding has been found, by this company, to be of very specific value. For example, a large fan blade broke at the base of the blade arms due to excessive wear. Since the steel arms are inserted in a cast iron hub, an entirely new hub with arms inserted would have been required to effect a repair without the use of welding. This, it is estimated, would have taken a week, during which time the blower would have been useless. However, by welding, this arm was fastened properly and, along with the other arms which showed wear, built up in the weak spot.

All Welded Water Pipe Line (See opposite page).

Summer Meeting of G. P. A.

Convention Papers Furnish Valuable Information On Pipe Welding and Use of Bronze Filler Rod for General Repairs

PUTTING it mildly the Gas Products Association Convention at French Lick Springs, Indiana, was a huge success. Furthermore, it was a success in every way, in the number who turned out for it, in the great interest shown in all its meetings, in the kind of actual and worth while work done, in the amount of work planned for the future, and last, but not least, in the good time it afforded everyone.

Some came to the convention in motor cars but the majority arrived by train Monday morning, June 21st, and the entire group spent the morning in playing golf, riding horseback and becoming acquainted. In the afternoon there was a very interesting meeting which was opened by an address by the Vice-President Mr. H. B. Pearson, who took charge of the convention in the absence of President M. L. Goodrich. Following Mr. Pearson there was a very interesting talk given by Mr. H. E. Wetzell, Engineer of the Smith & Oby Co. of Cleveland, Ohio. He talked on "Pipe Welding for the Building Contractor." He went into this subject in great detail using the blackboard in many instances to illustrate his various points. His talk showed wonderful possibilities for the use of oxy-acetylene welding and cutting in this field.

The second day of the convention was started off in the morning by a very informative address "Insuring Profits by Intelligent Pricing." This was given by Mr. W. L. Churchill, Industrial Engineer of New York City.

Mr. William Buttner of the Bastian-Blessing Co., Chicago was next on the program. His paper was "Using Steel in Manifolds." Following his talk Mr. E. L. Mills, also of the Bastian-Blessing Co., and Mr. Buttner gave a demonstration vividly illustrating their point.

Next Mr. Otto Adams of the Heylandt Sales Co., Chicago, demonstrated a device for converting the oxygen from the cylinder into liquid oxygen. This demonstration was extremely interesting and the device should have a great affect in experimentally introducing the oxy-acetylene industry into schools and colleges throughout the country.

On Tuesday afternoon the active members held a closed meeting while the apparatus group held a committee meeting at which there was a discussion of gauges for maintaining hose connections and standards and a discussion of certain threads for various apparatus and valve parts. On Wednesday morning Mr. W. C. Swift of the American Brass Co., New York, gave a most illuminating talk on "General Repairs with Bronze." His talk covered his extremely wide range of experiences received during his travels from coast to coast.

He told of his visits to railroad shops, manufacturing plants, garages and large and small welding shops, where he has seen the application of bronze welding successfully carried out on a very wide range of work. At this meeting reports were also made by Chairmen of the film committee, Apparatus group, and the Educational committee.

Mr. A. F. Jenkins of the Alexander Milburn Co., Baltimore, Maryland discussed the rules and regulations of the underwriter Laboratories in connection with the Portable Acetylene Generators. He was followed by Mr. Mills and Mr. Buttner of The Bastian-Blessing Co. who gave demonstrations and a description of the bursting of safety discs and cylinder valves. In the afternoon business meeting officers were elected, Mr. H. B. Pierson was elected President, Mr. W. H. Girdler, Vice-President and Mr. O. E. Engler, Second Vice-President.

Executive Committee

H. L. Pearson, M. L. Goodrich, W. H. Girdler, O. E. Engler, E. D. Findlay.

Directors for One Year

M. L. Goodrich, H. B. Pearson, W. H. Girdler, O. E. Engler, A. J. Russell, W. A. Sherman, E. D. Findlay, A. Roy Robson, H. Mueller, S. D. Winger, A. S. Bordeaux.

The illustration on page 23 shows: (1) George R. Strate, (2) J. S. Strate, (3) Elmer H. Smith, (4) Horace N. Smith, (5) A. R. Ludlow, (6) Walter H. Girdler, (7) A. J. Russell, (8) A. R. Ludlow, (9) Wellington W. Brothers, (10) W. C. Swift, (11) Joseph Halla, (12) Mrs. Wellington W. Brothers, (13) C. L. Gulick, (14) Mrs. Stuart Plumley, (15) Mrs. E. D. Findlay, (16) Mrs. R. H. Sullivan (17) Mrs. A. F. Jenkins, (18) Mrs. Horace N. Smith, (19) A. J. Russell, (20) Mrs. Stuart Plumley, (21) Mrs. A. F. Jenkins, (22) Mrs. Horace N. Smith, (23) Elmer H. Smith, (24) A. F. Jenkins, (25) A. S. Bordeaux, (26) E. D. Findlay, (27) Otto Adams, (28) W. F. McKay, (29) Joseph Halla, (30) W. A. Slack, (31) Walter F. Verkamp, (32) Irwin F. Fausek, (33) Mrs. Wellington W. Brothers, (34) C. A. Kurz, Jr., (35) F. E. Verkamp, (36) H. B. Pearson, (37) E. A. Faulhaber.

Register of Attendance

Executive.

Pearson, H. B., Vice-President, Gas Products Association, Chicago, Ill.; Allen, Chas. T., Secretary and Treasurer, Gas Products Association, Chicago, Ill.; Luening, E. G., Chief Engineer, Kentucky Oxygen Hydrogen Co., Louisville, Ky.

Active Members.

Bordeaux, A. S., Vice-President and General Manager, Michigan Oxy-Hydric Company, Muskegon, Mich.; Brant, J. R., Vice-President, Indiana Oxygen Company, Indianapolis, Ind., and Wisconsin Oxygen Company, Kenosha, Wis.; Burdett, J. B., Burdett Oxygen Company, Chicago, Ill.; Butler, John T., Manager Burdett Oxygen-Hydrogen Company, Pittsburgh, Pa.; Faulhaber, E. A., President Burdett Oxygen Co. of Detroit, Burdett Oxygen Company of Texas and Burdett Oxygen-Hydrogen Co., Pittsburgh, Pa.; Findlay, E. D., President, Acme Oxygen Company, Chicago, Ill.; Gardner, R. V., Sales Manager, Kentucky Oxygen-Hydrogen Co., Louisville, Ky.; Girdler, Walter H., President Kentucky Oxygen-Hydrogen Company, Louisville, Ky.; Hord, Sam R., District Manager Burdett Oxygen Company, Ft. Worth, Texas.; Heyman, Ed., Engineer, Memphis Oxygen Company, Memphis, Tenn.; Hendricks, W. P.; District Manager Burdett Oxygen Company, Chattanooga, Tenn.; Kurz Jr., C. A., Treasurer and General Manager, Dayton Oxygen & Hydrogen Products Company, Dayton, Ohio; Lacey, W. J., District Manager, Burdett Oxygen Company, Oklahoma City, Okla.; Mott, Chester, Engineer, Compressed Gas Corp., and Purox Company, Denver, Colo.; Martin, S. B., Salesman, Kentucky Oxygen-Hydrogen Company, Louisville, Ky.; McKay, W. F., Chief Engineer, International Oxygen Company, Newark, N. J.; Russell, A. J., General Manager, Bettendorf Oxygen-Hydrogen Co., Bettendorf, Iowa; Smith, Elmer H., President Commercial Gas Company, Minneapolis, Minn.; Smith, Horace N., Manager, Memphis Oxygen Company, Memphis, Tenn.; Sullivan, R. H., Engineer, Acme Oxygen Company, Chicago, Ill.; Thomas, C. R., President Ohio Oxygen Company, Niles, Ohio; Verkamp, F. E., Ohio Valley Oxygen Company, Cincinnati, Ohio; Verkamp, Walter F., Secretary-Treasurer, Ohio Valley Oxygen Co., Cincinnati, Ohio; Wilkinson, F. B., President Logansport Oxygen Company, Logansport, Ind., and Ohio Valley Oxygen Company, Cincinnati, Ohio; Winger, S. D., Vice-President, Gas Products Company, Columbus, Ohio.

Associate Members.

Adams, Otto, Vice-President and General Manager, Heylandt Sales Company, Chicago, Ill.; Brothers, Wellington W., Editor Welding Engineer, Chicago, Ill.; Burdett, J. B., Burdett Mfg. Company, Chicago, Ill.; Buttner, Wm. C., Engineer, Bastian-Blessing Company, Chicago, Ill.; Brown, C. W., Manager, Innis Speiden & Co., Chicago, Ill.; Chesak, Wm. J., President Acetylene Products Co., El Paso, Texas; Chur, W. J., District Manager, Shawinigan Products Company, Pittsburgh, Pa.; Dieckelman, Robt. P., Secretary, Pressed Steel Tank Company, Milwaukee, Wis.; Duncan, David C., Vice President American Carbolite Sales Company, Duluth, Minn.; Fausek, A. J., Manager, Modern Engineering Company, St. Louis, Mo.; Fausek, Irwing, Manager Sales, Modern Engineering Company, St. Louis, Mo.; Flood, E. J., District Sales Manager, Page Steel & Wire Company, Chicago, Ill.; Fulton, W. J., Works Superintendent, Shawinigan Products Company, Keokuk, Iowa; Flaherty, John J., Page Steel & Wire Company, Bridgeport, Conn.; Gulick, Chas. L., Cylinder Sales Manager, Wm. Wharton Jr. & Co., Inc., New York City; Halla, Jos., National Gauge & Equipment Company, Chicago, Ill.; Jenkins, Alex. F., President and Treasurer, Alexander Milburn Co., Baltimore, Md.; Kelly, J. J., District Manager, Shawinigan Products Company, New York City; Macauley, A. M., Treasurer, Grand Rapids Welding Supply Company, Grand Rapids, Mich.; Mills, E. L., Sales Manager, Bastian-Blessing Company, Chicago; Plumley, Stuart, Managing Editor, Acetylene Journal Publishing Co., Chicago, Ill.; Slack, W. A., President, Torchweld Equipment Company, Chicago, Ill.; Smith, Otis L., President and General Manager, Weldit Acetylene Co., Detroit, Mich.; Swift, W. C., Research Engineer, American Brass Company, Waterbury, Conn.

Guests.

Ackerman, E. C., Salesman, National Carbide Sales Co., New York City; Boyer, Frank A., President, Standard Steel & Wire Company, Greensburg, Pa.; Churchill, W. L., Industrial Engineer, White Plains, N. Y.; Fischer, J. H., Erecting Engineer, Chicago, Ill.; Keeley Jr., W. C., Vice-President, National Carbide Sales Co., New York City; Law, B. N., District Manager, Air Reduction

C.P.A.
CONVENTION
JUNE 21-22-23
1926
FRENCH LICK
INDIANA

Sales Company, Chicago, Ill.; Ludlow, A. R., First Vice-President, Air Reduction Company, New York City; Menzies, J. C., Cleveland, Ohio; Sexton, E. M., Railroad Sales Manager, Air Reduction Sales Co., New York City; Smith, C. F., Secretary-Treasurer, Sight Feed Generator Company, West Alexandria, Ohio; George R. Strate, Works Manager, Keokuk Plant, National Carbon Corp., Keokuk, Ia.; Strate, J. S., District Manager, Air Reduction Sales Company, Milwaukee, Wis.; Swain, John, General Manager, Union Carbide Sales Company, New York City; Trees, Clifford, Carbo Oxygen Company, Pittsburgh, Pa.; Walker, Geo. B., Vice-President, Union Carbide Sales Company, New York City; Wetzell, H. E., Engineer, the Smith & Oby Company, Cleveland, Ohio.

Ladies.

Mrs. Wellington W. Brothers, Evanston, Ill.; Mrs. E. D. Findlay, Chicago, Ill.; Mrs. Alex F. Jenkins, Baltimore, Md.; Mrs. C. A. Kurz, Dayton, Ohio; Miss Kurz, Dayton, Ohio; Mrs. E. G. Luening, Louisville, Ky.; Mrs. A. M. Macauley, Grand Rapids, Mich.; Mrs. Stuart Plumley, Winnetka, Ill.; Mrs. Elmer H. Smith, Minneapolis, Minn.; Mrs. Horace N. Smith, Memphis, Tenn.; Mrs. Otis L. Smith, Detroit, Mich.; Mrs. R. H. Sullivan, Chicago, Ill.

POWER SHOW WILL HAVE NEW FEATURES THIS YEAR

The spectacular use of vertical whirling shafts as sails to propel a ship will be demonstrated at the Power Show to be held in the Grand Central Palace from December 6 through 11, 1926. There will be a small model of the rotor ship designed by Anton Flettner which arrived in New York harbor during May, having come all the way from Europe by the force of the wind acting on the two vertical rotors with which the ship was equipped. In addition, Mr. F. O. Willhoft, the American representative of Mr. Flettner, will give a demonstration lecture about the "Magnus effect" which Mr. Flettner put to practical use in the rotor ship, and which the baseball pitcher uses when he curves a baseball. Mr. Willhoft will have many models and some interesting moving pictures by which he will show how the "Magnus effect" may be used to secure a large number of useful results.

The inclusion of the rotor ship exhibit and lecture in the plans for the Power Show is in accord with the policy of the management of the show to increase the educational value of this important exposition which annually attracts over 80,000 visitors.

The spectators are not only interested in the latest devices in the power and mechanical fields, they are also in search of interesting and novel ideas that will assist them in their problems. To satisfy this demand there will be an interesting series of educational exhibits and demonstrations.

The second exhibit under preparation is the method of laying out piping for power plants by the use of isometric drawings. Mr. V. L. Sherman, of the Lewis Institute of Chicago, is preparing the display which will demonstrate the isometric layout of piping which may be made quickly on the blackboard or on prepared isometric paper. This procedure will prevent many errors which now creep into the layout of piping and thus save much time and effort. The display will also contain many examples of complicated isometric pipe layouts from abroad as well as from this country.

The managers of the Power Show are Fred W. Payne and Charles F. Roth with offices at the Grand Central Palace.

WELDING A BUZZ-SAW

By Charles Haeusser

About two years ago I had to tell one of my customers how sorry I was because I could not weld a cracked buzz-saw which he brought in. I explained to his entire satisfaction how the strains are locked up in high carbon steel and how preheating and welding released these strains, causing the saw to warp and buckle hopelessly out of shape.

Today we weld these saws successfully up to 12 inches diameter and ⅛ inch thick. Our procedure is to bevel out the crack with a grinder from both sides and drill a small hole through the saw at the end of the crack, then we preheat the saw almost to a red and weld it with a nickel steel wire. We use a strictly neutral flame, fuse it and puddle it well and avoid flying sparks which are an indication of overheating and burning. After welding all excess metal is ground down flush with the surface. The saw is now welded but too badly warped to be of any use, so we have had to find a way to straighten it and temper it at the same time. We keep on hand two surface plates weighing over 100 pounds each, one of these plates is suspended about six inches above the other by means of a rope over a pulley in the ceiling. This rope returns to the bench, passing through two eyebolts. The saw is then heated to a good red heat in a charcoal fire. A pair of hot blacksmith tongs are used to place the blade quickly between the surface plates, the rope is released quickly so that the top plate falls on the saw. In a few minutes the saw can be taken from between the heavy iron plates perfectly straight and usually with the right temper. If the saw is very thin and comes out a little too hard for filing, place a sheet of asbestos paper on the lower plate and proceed as usual.

AUTO BUS FOR PORTABLE WELDER

A peculiar use of an auto bus has been made by the Prospect Boiler Works, New Brunswick, N. J., this company having installed a General Electric arc welder and an air compressor in the bus for field welding.

The arc welder and the air compressor are gas engine driven, allowing work to be done at any location, regardless of external power supply. Equipments of this kind are usually mounted on motor trucks, but the use of an enclosed motor bus is novel. The Prospect Iron Works has found it to be a real advantage, as the welding equipment is protected from the elements by being totally enclosed, most welding trucks using canvas side curtains for this purpose. The fact that the bus can be driven faster than the average truck is one of the desirable features, as the work covers a large territory. The outfit also proves to be quite an advertisement, resulting in increased business for the owner, and the bus is rapidly paying for itself.

Exterior and Interior of Portable Welder.

Factors Affecting Arc Stability

A Study of the Metallic Electric Arc, Indicating the Importance of Electrode Material as Affecting the Welding Operation

By J. B. Green, M. E.*

THERE are a number of subjects which, if completeness is aimed at, must be considered in a discussion of the reasons back of the effect of surface materials on the metallic arc. These are Electrical Stability, Chemical Stability, Distribution of Heat in the Arc, and Penetration. Only the first one will be considered here. In explaining the fundamentals of electricity, the use of mathematics seems unavoidable. Every welder is familiar with Ohm's Law

$$\frac{\text{Volts}}{\text{Amps}} = \text{Ohms}$$

or written with the customary mathematical symbols

$$\frac{E}{I} = R$$

There is another law which is not so well known applying to arc stability. This probably should be called Rasch's Law. In symbols it is expressed as follows:

$$S = \frac{E_o}{I} - \frac{K_s L}{I^2}$$

S=what might be called "Stability Units."

E_o=Overvoltage or generator voltage minus arc voltage. It is the voltage required to force the current through the ballast resistance.

I=Current in amperes flowing in the welding circuit.

L=Arc length in inches.

K_s=A constant of the electrode called "Stability Constant."

If figures covering a particular case are substituted for the symbols in Rasch's formula, and it is found that when the equation is solved, S is zero or less than zero, that is minus, it is evident an arc cannot exist because it would have zero or less stability. On the other hand, if in a particular case, S proves to be positive, that is, has a value more than zero, an arc can exist, and the higher this value the more stable the arc.

The first term of the right hand number of Rasch's equation is $\frac{E_o}{I}$. Ohm's Law says that Volts divided by Amps. equals Ohms, so Overvoltage divided by Amps. in the welding circuit must equal the Over-resistance or the resistance outside the arc which might be called the External Resistance in Ohms. This gives an understanding of what $\frac{E_o}{I}$ in Rasch's equation means. The symbol R_n, or the external resistance in Ohms of the entire circuit outside the arc, could be used.

The current, which every welder knows is the same throughout the entire welding circuit, arc generator and all connections, and also the arc length need no comment.

The Stability Constant will need some explanation. This is the name given to the quantity represented by K_s in Rasch's equation by our Research Department because, unlike most familiar constants of materials, it has never been named. There are several constants of electrode materials which enter a complete discussion of the metallic arc. They are really the physical properties which control the arc so far as it is influenced by the electrode. Any physical property, which for the same material is always the same, is a constant of that material. Some of the more familiar constants of materials have names such as boiling point, coefficient of expansion, electrical conductivity, etc.

Study of Stability by Means of Rasch's Law

Rasch's equation tells us just what affects arc stability and what does not. It shows that the electrode affects stability because K_s, the Stability Constant of the electrode, is one quantity in the equation. If all the other quantities remained the same, and various electrodes used each having a different Stability Constant, the value of S or the Stability Units will be affected accordingly. Rasch's equation also tells us that the welder can affect the arc stability because L, the arc length, is one quantity in the equation and this is immediately under the welder's control. Every welder knows that for any one set of conditions there is one arc length easiest to hold. This merely means that at this length the Stability Units are the highest. More will be said of this later. The current source also affects stability because in Rasch's equation $\frac{E_o}{I}$ appears, which, as already explained, represents the external resistance, or in other words depends on the ballast resistance, etc., all usually considered part of the generator outfit. The total current flowing has a marked effect on stability because in Rasch's equation it appears as the square, the symbol I^2 being the denominator of the second term. The current, of course, is dependent on the generator, the welder and the properties of the electrode as will be appreciated with a moment's thought.

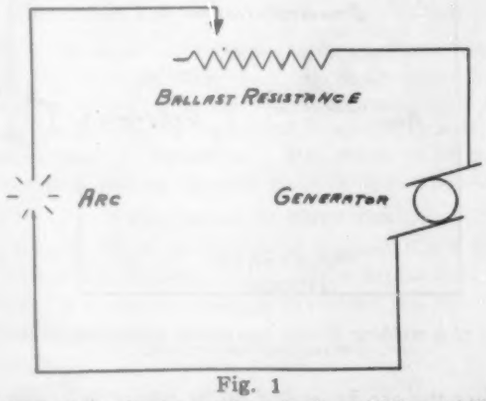


Fig. 1

Diagram of the simplest welding circuit containing stabilizing resistance only

Relationship of Factors Affecting Stability

Summing up, Rasch's equation shows stability is directly influenced by the generator, the welder, and the electrode and it furthermore shows the relationship of these influences. It remains to explain this relationship and the generator influence will be considered first. Most text books on welding cover this point, but not in connection with Rasch's equation. The arc is inherently unstable because as the voltage increases the current decreases and vice versa. This can be brought under control by using a ballast resistance as shown in the diagram of a simple welding circuit, Fig. 1. The arc thus only accounts for a percentage of the total voltage, but the current is controlled by the sum of the arc voltage and overvoltage. Selecting easy figures to illustrate this:

Arc Voltage=	20
Overvoltage=	80
Generator Voltage=	100

A change of 2 volts in arc voltage due, for example, to change of arc length, here represents a 10% change in arc conditions, 2 volts being 10% of 20 volts. However, 2 volts is only 2% of the 100 volts across the generator. It is the

*Research Department, Chicago Steel & Wire Company.

fluctuation in generator voltage drop that indicates the current flowing, hence in this case a 10% change in arc conditions only represents a 2% change in current. Ballast resistance thus actually stabilizes the arc. It is also possible to steady the arc. The difference between stabilizing and steadying should be clearly understood. There does not seem to be anything else just like the metallic arc, so there is nothing that represents a perfect comparison. Consider, however, an ordinary packing box. If this is laid on the floor on its flat side it stays there, but if laid on a corner it will tip over unless someone is there to steady it. A constantly changing quantity of energy is required to keep the box upright when laid on its corner. When on its flat side, force, to a certain limit at least, can be applied to first one side then another, but the box still remains upright. Any influence that tends to keep the arc going by changing the energy in the welding circuit is said to steady the arc while any influence that tends to keep the arc going independent of a change in energy stabilizes it.

In Fig. 2, a slightly more complex welding circuit is shown which, in addition to the ballast resistance, includes an inductive resistance. This acts like a flywheel on an engine.

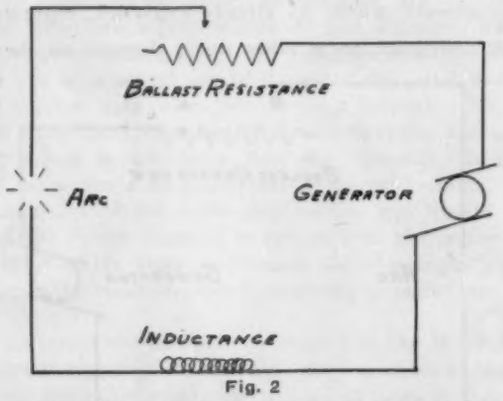


Fig. 2

Diagram of a welding circuit containing stabilizing resistance and steadying inductance.

It steadies the arc by giving up or taking in energy as required. In addition to this inductance, most welding generators are built with compensating windings, the manufacturers being very ingenious in designing these. They steady the arc by controlling the energy as a governor does on an engine.

The flywheel and governor effects of inductive coils and special generator windings steady the arc by varying the energy supplied as required while ballast resistance makes the arc inherently stable. As Rasch's Law is concerned entirely with stability, it takes into account ballast resistance only. This might be made clearer if we go back to Fig. 1 showing the simplest welding circuit. It is easy to see how Rasch's Law applies here. Suppose an arc with this circuit is run long enough to measure the volts, amperes, arc length and electrode constant. These figures can then be submitted in Rasch's equation and the Stability Units figured. Next suppose that a different generator be put in the circuit supplying a different amount of energy and the arc again run long enough to measure the volts, amperes, etc. These figures can then be substituted in Rasch's equation and the Stability Units figured. The effect of the inductive coils and generator windings is the same as changing the generator to one supplying different energy in the simple circuit only now it is done instantly and automatically in a way that keeps the values of volts and amperes as nearly as possible such that, if substituted in Rasch's equation, the maximum Stability Units will result. It might be interesting to some to remark here that these automatic steadying devices found in welding generator sets have been largely designed to compensate only for arc changes due to differences in arc length. Rasch's Law, however, shows that the Stability Constant of the Electrode is also involved. Thus, if the generator takes care of changes in arc length automatically for one electrode, it does not necessarily mean that it will do so equally well for another electrode having a very different Stability Constant. Welders who have worked with a variety of different generators and electrodes are familiar with this from experience.

Consider next the electrode material. Every welder knows that different electrodes will maintain different maximum arc lengths. This is due to the properties of the material represented by the Stability Constant. If the arc length is increased, the arc is extinguished just as it reaches maximum and as it goes out, stability becomes zero. If Rasch's equation is written using zero for S, the Stability Units, and L_{max}, meaning the maximum arc length, for L, the arc length, it appears as follows:

$$0=\frac{E_o}{I}-\frac{K_s L_{max}}{I^2}$$

Solving this by ordinary algebra for K_s gives

$$K_s=\frac{E_o I}{L_{max}}$$

It is a comparatively easy matter to obtain the figures for E_o, I, and L_{max} for any electrode and with these it becomes easy to compute the value of K_s, the Stability Constant. For electrodes in common use, this constant seems to have values of from 2000 to 5000.

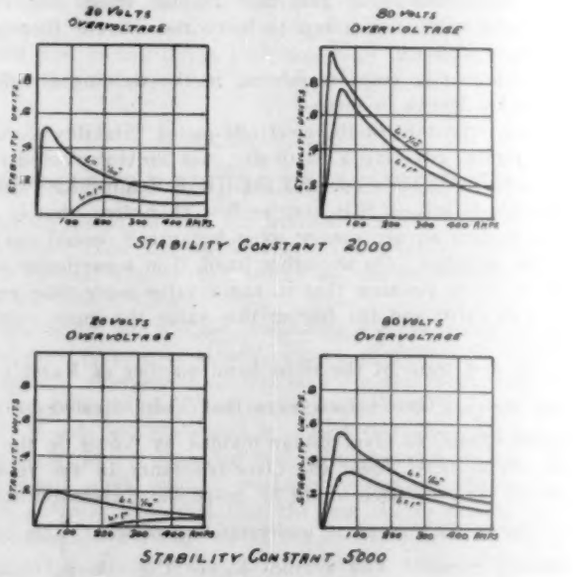


Fig. 3

Rasch's equation for stability plotted as curves, using extreme values of arc length, ballast resistance, and stability constant.

It is hardly necessary to comment on the effect of arc length on stability except in one respect. Every welder realizes there is always one particular arc length which is easiest to hold for any given set of conditions. This might be called the optimum or best length and given the symbol L_{opt}. With the aid of calculus it can be shown that

$$L_{opt}=\frac{1E_o1}{2\ K_s} \text{ and } L_{max}=\frac{E_o I}{K_s}$$

From these two equations it will readily be seen that

$$L_{opt}=\frac{1}{2}L_{max}$$

This is a good thing to remember and so far as possible arrange the generator so that the maximum arc length is just twice the desired working length. Remember that, if this is to be applied practically, by testing the maximum arc length with commercial welding generators, that the overvoltage and current must be kept the same when determining the

maximum arc length, as they are under working conditions. This is impossible with some generators on account of the automatic regulation which is thus not under manual control.

The effects of all these variables appearing in Rasch's Law can best be understood by the use of the curves shown in Fig. 3. In drawing these curves, figures have simply been substituted for the mathematical symbols and Rasch's equation solved for Stability Units. These have been plotted for the corresponding values of current. There are four cross-sections in this set of curves and on each one there are two curves. The top curve in each case is for an arc length of $\frac{1}{10}$ inch and the bottom for 1 inch, these being taken as the extremes that would ever be met in practice. The two top cross-sections are for an electrode with a Stability Contant of 2000, the left cross-section showing the curves when the ballast resistance requires 20 volts Overvoltage and the right cross-section when 80 volts Overvoltage are required. These values of Overvoltage are selected as representing the extremes. Similar remarks apply to the two bottom cross-sections only here an electrode is represented with a Stability Contant of 5000. These curves permit almost at a glance studying the general effect on stability of arc length, overvoltage and electrode material over the maximum range which might be expected in commercial practice. It just so happens that using inches, volts, amperes, etc., that the Stability Units appear as decimals. This does not mean that they are small and of no consequence. It is the relative value of these Stability Units that counts. If under one set of conditions the stability is .6 and another set .2, it means the arc is three times as stable under the first set of conditions as under the second.

Theory Concerning Effect of Surface Materials

All that has been said so far in this technical discussion of Electrical Stability is really leading up to an explanation of why surface materials on an electrode affect stability. It must always be remembered that the electrode includes both the metal and what is on the surface and the surface consequently affects the value of K_s, the Stability Constant. Our tests indicate that it often has a much greater affect on this constant than the composition of the metal of the electrode.

The influence of surface materials on arc stability can be approached from another angle and this may be clearer than any reference to Electrode Constants. Students of electricity divide materials from the standpoint of electrical conductivity into two groups. These they call "Conductors of the first class," and "Conductors of the second class." First-class conductors are represented by the metals while second-class conductors, to which lime belongs, are what are commonly called insulators. The fact of the matter is that both groups are conductors or insulators depending entirely on the temperature. The higher the temperature the lower the conductivity of metals, or first-class conductors, and the higher the conductivity of all second-class conductors. At arc temperatures, this becomes very pronounced and it is easy to imagine that iron vapor in the arc is almost an insulator while lime vapor becomes a very good conductor. In other words, the presence of second-class conductor on the surface of electrodes even in small quantities could supply enough vapor to the arc stream to substantially affect the resistance of this vapor. Apparently it takes not very much of the vapor of a second-class conductor to saturate the arc. Any excess over this merely escapes in the air and any less than this does not give the maximum benefit.

It remains to show mathematically the significance of arc vapor resistance in connection with stability. Consider the arc vapor stream only and apply Ohm's Law.

$$\frac{\text{Volts}}{\text{Amps}} = \text{Resistance, or in symbols } \frac{E}{I} = R$$

If the resistance of the arc vapor stream is lowered, it means that Volts divided by Amps has a less value, or in symbols, if R is made smaller, $\frac{E}{I}$ must become smaller to be equal to R. The value of a fraction as $\frac{E}{I}$ can be made smaller either by increasing the denominator I or decreasing the numerator E. The use of most any figures shows this clearly. For example take the fraction $\frac{2}{5}$, increase the denominator from 5 to 10 and decrease the numerator from 2 to 1 thus:

Original fraction	$\frac{2}{5} = .4$
Increase denominator	$\frac{2}{10} = .2$
Decrease numerator	$\frac{1}{5} = .2$
Both increase denominator and decrease numerator	$\frac{1}{10} = .1$

Such a reduction must occur with the fraction $\frac{E}{I}$ because it is a well-known fact that in the metallic arc as the volts E go down the current I goes up and this is just what happens when the resistance of the arc vapor stream is reduced. For convenience in reading, the mathematical expression for Rasch's Law is repeated

$$S = \frac{E_o}{I} \quad \frac{K_s L}{I^2}$$

E_o is the Overvoltage outside the arc stream so it need not be considered if held constant. I, the current, of course, flows through the arc stream. As explained above, this goes up as the arc stream resistance goes down. The second member of Rasch's equation is composed of two fractions, I being the denominator of the first and I^2 the second. Remembering what was said of fractions above, as I is increased the value of $\frac{E_o}{I}$ is decreased and this is also true of $\frac{K_s L}{I^2}$ but this latter quantity is decreased more than the first because the denominator is I^2. The net stability is the first fraction minus the second one. It is easy to see that if, no matter how much the first fraction is reduced the second is always reduced in value still more, that it represents a less value to be subtracted from the first and so the net stability is increased.

Comparison of Electrodes

It is usually easier to understand mathematics if figures are used instead of symbols so the above explanation with the addition of a consideration of Overvoltage will be repeated in this way as follows:

	Symbol	Electrode No. 1	Electrode No. 2
*Arc Length	L	.2 inches	.2 inches
Arc Vapor Resistance	R_A	.25 ohms	.15 ohms
*Ballast Resistance	R_B	.25 ohms	.25 ohms
Total Resistance	R_T	.50 ohms	.40 ohms
*Arc Voltage	E_A	22 volts	17 volts
Overvoltage	E_o	28 volts	33 volts
*Generator Voltage	E_G	50 volts	50 volts
*Current	I	100 amps.	125 amps.
*Stability Constant of Electrode	K_s	3500	2500
Stability Units of Arc	S	.210	.233

Electrode No. 1 gives the higher resistance arc vapor and Electrode No. 2 the lower. The items preceded by an * are observed and the others are computed by ordinary arithmetic with the aid of Ohm's and Rasch's Laws.

It will be noted that the Electrical Stability increases almost exactly 10% in this particular case. For the purposes of comparison everything has been held constant except the electrode. The fact of the matter is that an increase of 10% in Electrical Stability is really much greater than this so far as the welder is concerned. It permits holding a shorter arc length which still further tends to increase Electrical Stability and Chemical Stability, which is not treated in this article, is greatly increased. By looking back at the curves in Fig. 3, it will be seen that the greatest variations in Electrical Stability occur below 100 amperes while at 500 the stability does not change much even under a wide variation in conditions. This means that the small size electrodes must be considered far more carefully from the standpoint of stability than the large ones. These curves also indicate the manner in which arc vapor resistance affects stability. The curves for $\frac{1}{10}$-inch arc length are all above those for 1-inch arc length or in other words for any given set of conditions the short arc is more stable

(*Continued on Page* 35)

Gas Welding Alloy Steels*

How High Carbon Steels and High Speed Steels Can Be Successfully Welded—Some Applications of the Process

By G. L. Walker†

THE welding of high carbon tool steels and high-speed steels has an extensive field for development and one that has already met with considerable success. There yet remains a need for further study and development in methods and materials before these steels are as successfully and as extensively welded as are the lower carbon steels.

It is quite difficult to give a hard and fast rule for welding high-speed steels that will meet every demand. The piece that is to be welded, its design and purpose for which it is to be used as well as the chemical characteristics of the metal within the zone of welding, have an important influence on welding procedure. The experience of the welder also must be considered.

There are, however, some rules to be observed in welding these steels that are almost fundamental and which must be followed if any degree of success is to be realized.

High carbon tool steels are those steels containing from about 0.60 per cent carbon to 1.50 per cent carbon, and it is by reason of this high carbon content that they can be hardened and tempered and thereby serve in the cutting of metals.

High carbon tool steels are used principally in making tools of various kinds, such as milling cutters, drills, reamers, files, lathe tools, saws, hammers, wrenches, and for many other purposes where a tool possessing hardness and resistance to wear or abrasion is required.

High-speed steels are those steels of comparatively low carbon content which depend for their hardness on the use of tungsten and chromium. They also contain other metals, such as vanadium, cobalt, manganese and molybdenum.

High-speed steels are used in making all kinds of tools, especially lathe and shaper tools, milling cutters, drills, reamers, gas engine valves, and for all purposes where great efficiency, high-speed cutting and heat-resisting qualities are required.

The use of high-speed steel has had a great influence on machine shop practice in that tools made from this steel are able to maintain a cutting edge when heated to a temperature that would ruin the best of carbon tool steels. This ability to maintain hardness when heated to a high temperature has resulted in an enormous increase in the speed of cutting. High-speed steels very considerably in their composition. Analysis of many steel show following range:

Carbon	0.55- 0.85 per cent
Tungsten	12.00-20.00 per cent
Chromium	1.00- 8.00 per cent
Vanadium	0.50- 2.50 per cent
Cobalt	varying amounts
Molybdenum	varying amounts

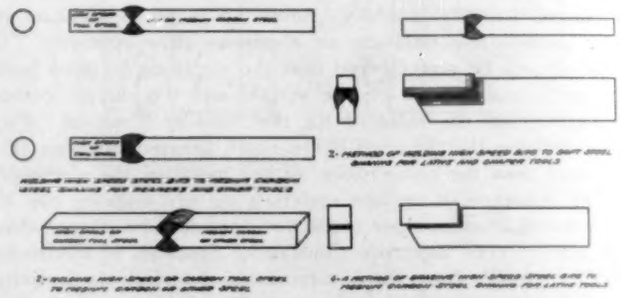
Often, other metals are alloyed with high-speed steels. Some special steels may have a greater or less amount of the constituents in their compositions.

The part played by tungsten in high-speed steels is to raise the temperature at which hardening is effected and also to raise the temper temperature. A straight carbon tool steel will begin to soften at 400 to 500 degrees F., and at 1100 degrees F. it will be annealed and not fit for a cutting tool. The addition of tungsten, however, not only permits retention of the hardness incurred by rapid cooling but also under proper conditions considerably increases the hardness when the steel in reheated to a temperature as high as 1100 degrees F. This means that it is possible to use a speed of cutting such that the cutting edge of the tool will reach a dull red color. The addition of chromium to the steel containing tungsten not only greatly increases the hardness of the steel but also produces a lowering of the temperature at which secondary hardness takes place on tempering.

In the carbon tool steel the amount of carbon in the steel is dependent upon the purpose for which the steel is used.

From 0.60 to 0.85 per cent carbon is used in steel for hammers, rivet sets, blacksmith tools, forge dies and all tools where a great toughness combined with the proper hardness is required.

From 0.85 to 0.95 per cent carbon is used in steel for pneumatic chisels, punches, shear blades and so forth. From 0.95 to 1.15 per cent carbon is used in steel for milling cutters, mandrels and general machine shop tools; in fact, all tools requiring a keen cutting edge combined with hardness and toughness. From 1.15 to 1.25 carbon is used in steel for lathe and shaper tools, drills, taps, reamers and all tools requiring a keen cutting edge combined with great hardness. Steel containing above 1.25 carbon is used where great hardness is the main requisite. High-carbon tool steel may also have other metals alloyed with it, such as vanadium.



Figures 1, 2, 3 and 4.

In the welding of tool steel the carbon content is an important factor to consider. A steel with a carbon content of from 0.60 to 0.85 per cent may be welded fairly easily by a welder who exercises ordinary care and is at all familiar with steel welding. With a carbon content of from 0.85 to 1.00 per cent the welding is more difficult, and from 1.00 to 1.50 per cent great care is required in making a weld, and a degree of care that can only be attained by experience in welding steels with such high carbon content.

All metal cutting tools are subjected to a number of stresses, all of which are important factors in the proper selection of the steel for the tool and also because of their effect on the welds. Drills, reamers and taps are subjected to torsion stresses and also to tension stresses. Lathe and shaper tools are subjected to transverse stresses. Milling cutters have to endure nearly every type of stress. The cutting edge of all metal cutting tools especially must not only have good wearing qualities but because of its extreme fineness and its functioning in the cutting of metals must endure practically every stress. It is because of this fact together with the welding qualities of the metal that the welding of carbon tool steels and high-speed steels becomes a problem that has been harder for many welders to solve than the welding of mild carbon steel.

Both high carbon tool steels and high-speed steels have been

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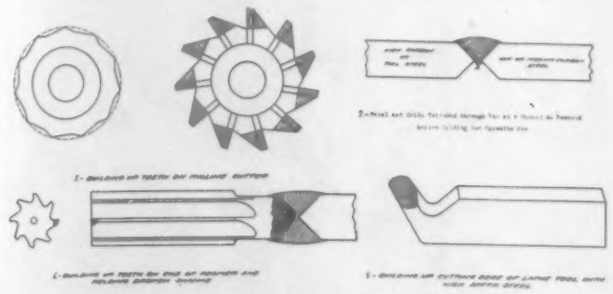
†Associate Research Engineer, Air Reduction Sales Company.

and are now being welded successfully. In reclamation and general repair work much has been accomplished in such work as building up the faces of hammers worn and chipped in use. Wrenches with broken or worn jaws are being reclaimed. Milling cutters and reamers with broken teeth are repaired, See Fig. 5 and 6. Form tools are being reclaimed by building up the worn part with high-speed and tool steel and regrinding to shape.

Lathe tools for use in heavy cutting are being made by welding a high-speed steel bit to a medium carbon shank, as in Fig. 3. Reamers are also made in this manner. See Fig. 1. Milling cutters and other steel cutting tools have been made by building up the cutting edge on a low chrome or medium carbon steel center. Gasoline



Figures 5, 6, 7 and 8.

engine dowels are made by welding low chrome steel stems to high-speed steel heads, as shown in Fig. 11.

Another use for both high carbon tool steel and high-speed steel is for building up parts of machinery, and so forth, which require a hard, erosion-resisting surface.

In the welding of high-speed steels I wish also to include stellite, an alloy of cobalt, iron, chromium and tungsten which is used for similar purposes as are the highspeed steels.

One of the main requisites in welding high carbon and high-speed steels are the torch and tips. They should be of a construction that will assure a good mixing of the gases before burning and a low gas ratio. Torches of this type are available.

The flame adjustment is also important. It should be a reducing flame for high-speed steels, stellite and the higher carbon steels. With the carbon steels this flame adjustment somewhat depends upon the carbon content. The lower carbon tool steels may be welded with a neutral flame, taking care that it is non-oxidizing. The higher carbon steels, however, require an excess of acetylene in the welding flame. It is difficult to describe the exact flame characteristic. Experience only can tell the welder the flame desired. It will vary slightly with the type of steel being welded.

The welding rod is also important. In the high carbon steels it should be of high-grade material, and not lower in carbon content than the steel to be welded. If the welding metal is to become part of the cutting edge it is preferable that the steel contain a slightly higher carbon content. This, however, is less important than that it be at least of as high a carbon content. Any great departure in the carbon content from that in the steel to be welded will make the welded metal either too soft to take the proper temper in the heat treatment, or too brittle to withstand the stress to which it will be subjected in use. There are many welds that can be made in tool steel where a much lower carbon steel can be used. This must be determined by the functioning of the tool itself as these welds are at a point remote from the cutting edge.

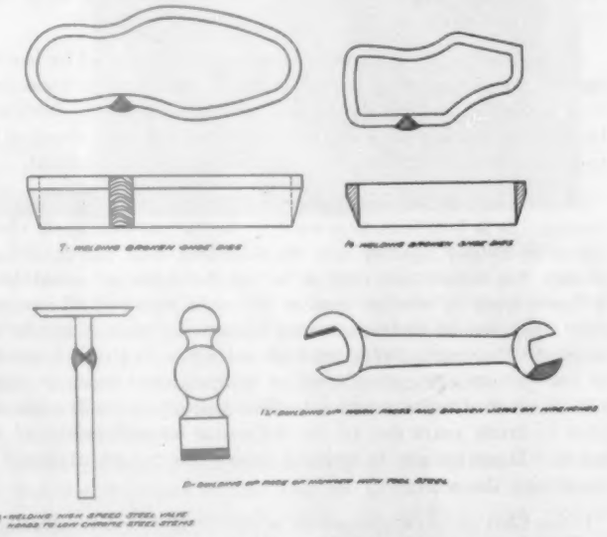
In preparation of the part to be welded a rather wide bevel on tool steel is preferable. This will make unnecessary the fusing down of the sides in making the weld. All parts to be welded should be carefully cleaned of dirt and rust.

The welding of high-speed steels while in general is not dissimilar to welding high carbon tool steel, requiring the same method of preparation and a welding rod that will flow freely and not cause blowholes. Heavy oxides from the chromium and tungsten usually form on the surface of high-speed steels in the melting operation, and blowholes become difficult to eliminate. It will be found advantageous to use, wherever possible—and it is usually possible—a high-speed steel filler rod containing vanadium and cobalt. These steels flow freely and very cleanly. I do not mean to infer that this steel is a better high-speed steel than any other as undoubtedly each type of steel has its important field. I refer to its weldability only and value as a filler rod.

The tip for welding all tool steels should be from one to two or even more sizes smaller than should be used for the average steel of the same dimensions. This, however, is controlled somewhat by the nature of the weld and the skill of the operator. But in general this rule holds good.

A flux is of great aid in welding tool steels; in fact, it is almost necessary in order to make good sound welds. A good cast iron flux will give good results on carbon tool steels. There are fluxes on the market that have been developed for tool steels.

One of the main precautions to be observed in welding all of the tool steels is to take care to not overheat the welded metal. Do not use any more heat than is necessary. Another precaution is not to rework the welded metal unnecessarily. Deposit the filler rod in thin layers when the base is ready to make a weld. Add the metal just fast enough to prevent it from flowing over where the base is not in a welding condition and then let it remain there and add more filler rod. Continue in this manner until the weld is completed. It is the frequent reworking of the weld metal that causes the most of the defective welds. It causes blowholes, and creates an excessive film of oxide that collects on the surface. The success or failure of the weld depends upon properly adding the filler rod.



Figures 9, 10, 11, 12 and 13.

When the welded joint is of the double vee type there will be some metal extended through the bottom of the vee when the first half of the weld is completed, Fig. 7. This extended metal is composed to a great part of oxides. It is better to remove this extended metal before starting the second half of the weld either by flowing it out of the vee with the torch or by any other means that will remove the oxide and prevent an excessive accumulation of it in the weld.

The high-speed steel should not be melted down in making a weld but rather the filler rod should be added to the surface, Fig. 2, taking care, of course, that the surface is in the proper state of fusion to take a weld. For this reason a wide bevel is of great advantage. The bevel should not be less than 45 degrees, and the combined vee not less than 90 degrees.

Where a carbon tool steel or high-speed tool steel bit is welded to a medium carbon steel shank or base and it is not desirable or practicable to bevel the bit, it is best to prepare the bit first by building up over the surface a conical or beveled section with the filler rod, Fig. 1 and 3. The filler rod should be of nickel or

vanadium steel in a weld of this type. However, other steels may be used as the filler. The bit is then placed in position on the shank or base and the same filler rod used to make the weld.

I have seen many failures in making these welds when the bit was not prepared in this manner but have always met with success when the bit has been prepared as I have just described. This type of weld is used on special reamers, heavy lathe and shaper tools and so forth.

Lathe tools of the forged carbon tool steel type have been modified by building up the cutting ends with high-speed steel along the lines shown in Fig. 8. Milling cutters, Fig. 5, have not only been repaired by building up broken teeth but new cutters have been made by using a low chrome steel center and building up the teeth with the oxyacyetylene flame. As an aid in this work a form or mold was made of graphite, approximating the shape of the teeth. The cutter base was mounted on a shaft or arbor so that it could be turned readily. The form was held in place and the weld made by carefully fusing the base and then filling up the form. These cutters were made in very short time and were highly successful. The filler rod was a cobalt high-speed steel. No heat treatment was required after welding. The cutter was ground into shape and put in service. In a test for comparison with a similar cutter made of high-speed steel by the casting process and a forged high-speed steel cutter the welded cutter gave approximately 60 per cent greater efficiency than the forged cutter, and about 30 per cent more than the one made by casting. The cutters used in the tests were 6 inches diameter by 1 inch face. The cut was 1 inch deep and was run at the highest speed possible. Identical results were obtained by the lathe tools built up as described.

Carbon tool steels after welding must be heat treated by hardening and tempering. A tool after welding requires to be normalized or annealed by cooling slowly before it is retempered. This may be done by heating with the welding flame and then covering the tool with dry ashes, lime or other heat-insulating material.

Hammering of the weld after completion must be done with caution. It is beneficial to a weld in the carbon tool steels where the parts welded together and the filler rod is of the same composition but where any part including the deposited metal is of different types of steel or even of the same type but of considerable difference in carbon content, hammering should not be attempted. Hammering of a weld where carbon tool steel is welded to low or medium carbon steel or to high-speed steel or where high-speed steel is welded to any other type of steel will cause the joint to break apart due to the difference in malleability of the metals. Many failures in welding these steels can be attributed to hammering the weld.

It has been my good fortune to be able to devote several months to welding tool steels. Much of this work was in development of new tools to which the oxyacetylene process appeared to be applicable and much of which in reclaiming defective tools. Some of the work was unsuccessful but much of it was highly successful. The failures were mainly due to commercial impracticability rather than to failure or lack of success of the welding itself. It is often quite difficult, in fact, impossible usually, to reclaim a tool or piece of machinery by welding when the weld is in a place that has been finished to an exact dimension and it is not allowable to regrind the tool below that dimension.

In general, I should say that success in welding high-speed or carbon tool steels depends upon the proper preparation of the steel for welding, the use of the proper filler rod, the proper flame characteristics, the size of welding tip and care in making the weld.

Failure is the result not only of not taking the proper precaution in preparing the work, selection of the proper filler rod and care in welding but to lack of experience and the inherent difficulty of welding many of the high-speed and high carbon steels.

AMESWELD SPOT WELDER

The Ames Company, of 302 Pearl Street, Brooklyn, New York, have recently announced a new model Amesweld Spot Welder. This new type machine is shown in the illustration. It has many exclusive features and its construction includes an automatic switch which can be changed instantly for time welding. The switch does not require an adjustment for different thickness of metal or for wear of the welding electrodes, and it is said that it eliminates arcing, sparking and carbonization.

Amesweld Spot Welder.

The Amesweld is made for 220 volts, 60 cycles, but can be furnished in any voltage or frequency desired. This machine is of rugged construction and a small number of parts make it fool-proof. In order to take care of conditions where direct current only is available, the welders are arranged to operate with rotary converter or motor generator sets and where particular requirements must be met special machines are designed.

NEW PLANT FOR "RACO" RODS

The Reid-Avery Company, Incorporated, 21st Street and Washington Avenue, Philadelphia, announce a new and larger plant for "Raco" rods. This modern wire drawing mill will enable increased production. It is located on the property of the Bethlehem Steel Company, at Sparrows Point, Maryland, immediately adjacent to their rod mill. By means of a special arrangement with the Bethlehem Steel Company, the Reid-Avery Company is enabled to control the entire manufacture of their product from ore to finished goods.

THE BASTIAN-BLESSING COMPANY TAKES OVER MATTINGLY AUTOMATIC SAFETY VALVE

The Bastian-Blessing Company, Chicago, have announced that they have taken over the production and all patent rights of the Mattingly Automatic Safety Valve. This valve has been advertised in The Welding Engineer and is known as a gas preserver. It is used with oxygen, acetylene and hydrogen. It operates by shutting off the flow of gas the moment there is more than the ordinary amount passing through.

Arc Welding in Tank Construction

Survey of Field Shows That Large Consumer Demand Already Exists for the Welded Product

ELECTRIC arc welding has been assuming a position of increased importance, as a process for joining of metal parts in the production of tanks, ranging all of the way from those used for underground gasoline storage to those employed for milk pasturizing.

In many fields the electric arc welded process has already proven so much more satisfactory than those joined with rivets, as to have brought about a customer demand which has resulted in a rapid change from the riveted to the welded process on the part of manufacturers.

Manufacturers who have had extended experience with both riveting and electric arc welding of tanks, find that the newer welding process substantially reduces the production costs over those obtainable on like riveting jobs.

These are a few of the high spots which have been brought out in connection with the relative merits of riveting and arc welding in the tank industry, as a result of a nation-wide survey of the industry, recently made by the John B. Abell organization of Cleveland, Ohio. Because the investigation was conducted in such a manner as to insure a frank expression of opinion and experience, and at the same time on a basis which would protect individual tank builders from any possible criticism as a result of a frank statement of their findings, the results are of especial value.

The majority of the important builders of different sorts of metal tanks were canvassed in the investigation. The producers questioned were selected at random and without previous knowledge as to whether they favored one or another method of joining the different units of their products. Firms from every section of the country were questioned; the only qualifications being that the companies be of recognized standing in their respective fields.

Due to the fact that a large per cent of the builders produce tanks to be used for a variety of purpose, no attempt was made to single out only such companies as confined their efforts to a single line. However, a tabulation of the results of the investigation shows that an outstanding portion of the plants covered manufacture tanks of one sort or another for the oil industry and that welded joints are particularly favored by such production.

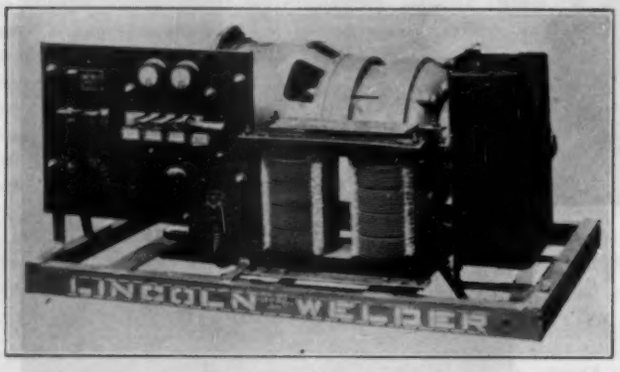
Before taking up a detailed study of the findings it is well to list the products turned out by firms covered in the investigation. These include tanks for underground gasoline storage, varnish and paints; water storage; tar; sugar refineries; syrup; beet sugar; sprinkler systems; steam; steel mill; soap factories; acids, slime, settling and pulp; scalding and rendering; all sort of oil storage and refinery work; marine purposes; refrigeration; gas; condensing; hot water; truck; paper mills and other uses.

In every case a series of twenty-two standard questions was presented to the manufacturer. In designing the questions care was taken to see to it that no advantage was set up for either electric arc welding or riveting, and provision was made so that those desiring to do so could make additional statements in support of the joining process favored.

The manner in which the questionnaire was prepared has served to make more striking the results of the investigation. Ninety-five per cent of the firms answering indicated that they use electric arc welding either in part or entirely for joining in the building of the products. While this finding by no means indicates that the rivet is practically extinct in the tank industry, for many plants employ both methods, it does show the rapidity with which the use of electric arc welding has and is spreading.

It should be kept in mind that while the use of rivets for joining has been the standard practice for many a decade, that the electric arc welding process is scarcely a decade old insofar as its application to production work is concerned. Only one builder indicated that the welding process had been in use for ten years in his plant a few reported they had followed the practice for five tor six years; while the average would not run over thre years, so that the fact that 95 per cent of the plants studied now employ the newer process merits careful thought.

Continuing the comparison along the same lines, we find that of the five per cent not now using electric arc welding in some form there are nearly one-fourth who indicate that in the near future they expect to apply the process on a portion of their tank work. It is of interest to note that the majority of the remainder of the plants employing nothing but the riveting process are engaged in specialized fields, rather than in the manufacture of a general line of heavy duty tanks.



With This Equipment, Making a Tank Seam Is a One-Man Job.

Reviewing the remarks made voluntarily by a number of firms it has been found that of the firms now employing welding only on part of their work, the majority contemplate the extension of this process to production now being handled by riveting where materials are of such a nature as to permit the change. On the other hand, there was not a single instance found where manufacturers either had or are expecting to change back to riveting upon jobs where electric arc welding replaced it.

It should not be inferred from the fact that 90 per cent of the firms covered in the survey, now utilize arc welding for some phases of tank building, that these companies have or immediately expect to use the process as a means of doing all joining. Although there are a goodly number of companies which are using nothing but electric arc welding on their products, some even stating that the success of their products has been largely built around welded connections, there are others which hold that the electric arc welding is not suited to the entire field of their products.

The consensus of opinion as expressed through the survey, is that other joining processes are only desirable where materials involved in the construction of given tanks are of such light gauge steel as not to lend themselves well to welded connections. Insofar as design, necessity of tightness, ability to withstand high pressure and constant abuse, those who have employed both the riveting and welding process indicate that the latter joining method provides the better results.

The few producers who actually indicated that they had never employed electric arc welding to their work and had no immediate intention of doing so, made no effort to show in what manner the rivet served to give a better product than does electric welding. Their support of the older method was largely based upon practice followed in their shops over a long period of years; the fact that a satisfactory market had been found for their tanks, or a tendency to "let well enough alone." This, of course, does not take into account those firms who held that their line was so restricted to sheet metal of a light gauge, as to make it impracticable to shift to welding at this time.

Turning to specific answers as to where welding or riveting has not ben found practical, the survey indicates some difference of opinion even among the producers who employ both processes. While as a general rule it was reported that electric welding was entirely satisfactory on tanks for high pressure work, there was one instance where it was stated that the manufacturer preferred riveting on this field.

On the other hand a number of firms indicated that they had found electric arc welding preferable to riveting on tanks which would be subjected to high pressure. Other specific jobs for which welding was frequently listed as being more desirable than riveting included small sized tanks; those where strength was of great importance; where tightness at seams is essential; general storage, underground and oil tanks, and for condensers. It was not an uncommon thing to find in the answers, firms building a general line of tanks and familiar with both welding and riveting reporting that while they would construct their producets with riveted joints if requested, yet they believed welding to be better for all of their tanks.

It was most generally agreed by those firms indicating that electric arc welding was not adapted to all of their work, that its employment was not suited to the real light gauge sheet steel. While some in this group stated that the process was not suited to work on sheets thinner than ten gauge, there were quite a few who use it up to 14 gauge, and some up to 18 gauge.

It was found by reviewing the answers to the questions as to what trades generally prefer electric arc welded tanks to the riveted products, that opinions varied greatly but that nearly all indicated one field in which the demand is outstanding in favor of the newer process. With but very few exceptions the firms engaged in the making of a general line of tanks for the oil industry, stated that the welded product was here preferred by the trade.

In addition to tanks for gasoline and oil storage of one kind or another, many firms stated that the trade is now calling for welding tanks to be used for both underground and above ground storage; in manufacturing processes; heavy heating and condensers.

Reasons given for having turned to the use of electric arc welding in the tank field cover a wide range. However, the outstanding reasons are: increased strength and tightness over rivets; ability to stand abuse without breaking or allowing leaks; adaptability to variety of work; increased speed in production; decreased comparative cost, and demands of the trade.

The last three mentioned reasons for turning to welding in preference to riveting appeared time and time again in the questionnaires. The one single reason which induced more firms to adopt electric arc welding in preference to riveting was that which had to do with cost. Almost universally the survey showed an agreement on the fact that the welded seam was more economical than the riveted joint.

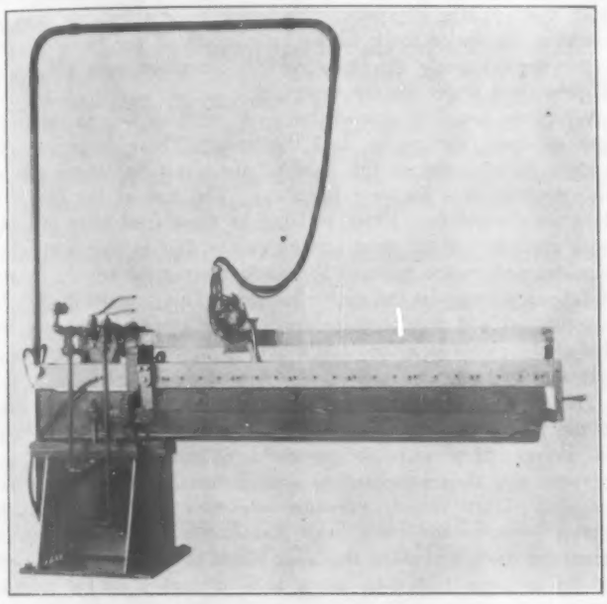
Largely in order to determine whether the switch from riveting to electric welding has involved any considerable expense due to the necessity of changes in design of products, producers were asked what affect if any welding had had on actual designs. In the majority of instances we found that there had been little or no changes in design involved and that in others changes made actually reduced production costs. For instance one large tank builder states that by applying welding to his products it has been possible to eliminate considerable flanging of heads and plates.

It was the desire of the investigators to know just why and to what extent the application of electric arc welding in the tank industry reduced costs, if it actually did do so. As to actual cost savings there was a wide difference of opinion, but it was generally agreed that welding did reduce the costs. Taking an average of the savings reported, the study shows that the welding

process reduces the production cost twenty-four per cent as against that for riveting like tanks.

Reasons given for the savings made possible by welding centered primarily around the claim that production speed is increased and labor costs out. Other savings listed by manufacturers included reduction in the quantity of material required for any given job, reduction in number of defective jobs and the like. One of the largest producers pointed out that welding could be done more cheaply than riveting because it eliminated a great deal of laying out, punching and sometimes shearing expense and at the same time reduced testing expense because fewer leaks showed up.

The smallest definite saving indicated by any firm questioned was ten per cent. At the other extreme, one firm reported that welding reduced labor costs up to eighty per cent on small tank work.



Automatic Tank Welder.

While of course, the difference in the amount of savings indicated by the report of different firms is in part accounted for by the variety of tanks built yet the survey served to bring out that much of the difference in savings affected by welding might be traced to three factors controllable by the separate plants. It appears that the degree of saving for each plant in large measure depended upon the manner in which the shop work was organized; the type of welding machines used, and the efficiency of operators.

Taking two shops which turn out practically like lines of tanks, the survey shows a wide range of difference in the savings made possible through the use of electric arc welding. One of the firms has been using the process on a large scale for the past ten years and reports an average saving of thirty per cent over riveting costs. The other company has been using welding but a little over a year and states that the saving thus far has been slight, but that as the process is better understood and the work becomes better organized they find the actual saving increasing.

The third point which producers have listed as being important in determining the savings on welded connections as against riveted, is largelly governed by the human element. The plants having had the greatest experience with this process state that it is essential that only well trained and experienced operators be employed on production work.

The Lincoln Electric Company of Cleveland is doing a good work in aiding and providing operators who have a basic knowledge of welding. More than a thousand men have been put through a practical course at the plant. Before leaving they are given actual welding work to do on production both in connection with the Link-Weld motor and the building of structural steel parts for the Stable-Arc welders.

After having made a thorough study of the replies to the twenty-two questions asked in the survey, one not help but come to the conclusion that electric arc welding is rapidly superseding riveting in the bulk of the tank industry. With all justice to rivets and to the few firms still sticking exclusively to their use, the facts force the conclusion that the trade is demanding the electric arc welded product because it stands up better and longer; and that aside from this demand it has been proven more profitable for manufacturers to use welding wherever possible because of the worth while production economies it assures.

GOOD PUBLICITY FOR WELDING

Welding enthusiasts will be interested in the following article which appeared in the Christian Science Monitor, March 13, 1926:

WELDING AVOIDS RIVETING NOISE

Electric Process Cheaper and Better, Engineering Society Finds

SCHENECTADY, N. Y., March 5 (Special Correspondence)—Electric welding eventually will replace largely the riveting process in the construction of steel frame buildings and will offer certain important advantages, according to recent studies made by the American Society of Mechanical Engineers and other interested persons. While the process is not in general use yet, engineers say it will spread rapidly in the near future.

The chief advantages of using welded construction are said to include: Less labor, decreased cost of construction, lighter weight, decreased noise and confusion, and increased rigidity and strength. In actual practice it has been found that one welder operator and a helper can do the work which formerly required a four-man riveting gang, it is explained.

Two identical buildings were recently built, one with a welded frame and one using the riveted type of construction. The cost of the riveted building, a shop 60 by 40 feet, was found to be 70 per cent greater than the total cost of the welded building. Further, the fabrication cost alone of the riveted building amount to 95 per cent of the total cost of the one whose frame was welded.

One of the biggest advantages of electric welding is the elimination of noise. Electric welding greatly simplifies the actual work as there is actual need for only one man, with a possible attendant; while in riveting, a man is required to operate the forge, another for the hammer, a third for holding the rivets, and a fourth as a helper. The riveting process requires a portable forge and a compressor used in operating the hammer. The electric welder, on the other hand, may be operated easily and does not require the constant shifting of heavy equipment.

In railway construction and repair work as well, it has proved its efficiency. In recent years it has been successfully applied, through the perfection of an automatic welding process, to many large industrial operations. The most elaborate feat of electric welding ever undertaken is now begun in California. Contracts for a water-supply pipe 85 miles long and five feet in diameter have been given to a bidder, who will install a welded line for the entire distance.

The success of welding as a substitute for riveting in all these and other operations has led the American Society of Mechanical Engineers to foresee for it an important future. Because of its silence of operation, the case and speed of the method, and the increase in durability of the finished work, it will eventually nearly displace riveting, it is expected.

C. A. COTTON APPOINTED NEW ENGLAND DISTRICT SALES AGENT BY BURKE ELECTRIC CO.

The Burke Electric Company, Erie, Pa., manufacturers of a complete line of alternating and direct current motors, synchronous motors, generators, motor generator sets, electric arc welding equipment and Universal motors, announces the appointment of C. A. Cotton, 135 High Street, Boston, Mass., as district sales agent for the New England territory.

Cutting Torch Serves Bankers

Ingenuity of Contractor Makes Possible Removal of Vault in Fraction of Time Specified in Their Agreement

OVER 400 tons of steel have just been taken from the First National Bank of Chicago. This great amount of metal was removed by means of the Oxy-Acetylene cutting torch. Mr. Joseph Flaxman of the J. Flaxman Iron Co., Iron Wrecking Contractors, Chicago, was in charge of this work and his ingenuity and ability saved the First National Bank just thirteen days.

To begin at the beginning the First National Bank wanted to remove their large safety deposit vault and use the space for additional office space. The idea was also to construct a larger vault in another part of the building. One can readily grasp the immensity of the task by visualizing this vault. It was a rectangular room 50 feet square and of average height. All six of the walls were made of four layers of laminated steel. These four layers of steel were bolted firmly together and to attempt to unscrew them would have been out of the question as construction and the great number of them would have consumed an enormous amount of time and labor. The four laminated plates which were bolted together were unique in their construction. The first outside layer was fairly soft while the second and third layers were extremely hard and the fourth layer was hardest of them all being made of pure Bessemer steel. The first three layers had similar construction. They consisted of five layers or laminations each. The first lamination was Bessemer steel $\frac{1}{16}$ of an inch thick but it was composed of a steel high in manganese and sulphur. The third layer was similar to the first, and the fourth layer was similar to the second, while the fifth layer was also the same as the first and third.

These laminated layers of steel were drill proof and the only possible way which this work could be done within a reasonable period of time was by using the Oxy-Acetylene cutting torch.

Working conditions were extremely bad as there was only one small window in the room containing the vault and this small window was by no means adequate to remove the gases and fumes. Fans and blowers were used to alleviate this condition but even with their aid it was impossible to keep a single cutter on the job for more than one-half an hour at a time. From time to time various officials of the bank came down to see how the work was progressing but they were only able to stand the atmospheric conditions for about five or ten minutes when they would beat a hasty retreat. The high sulphur contents of the steel and the lamination was the principal cause of the distressing fumes.

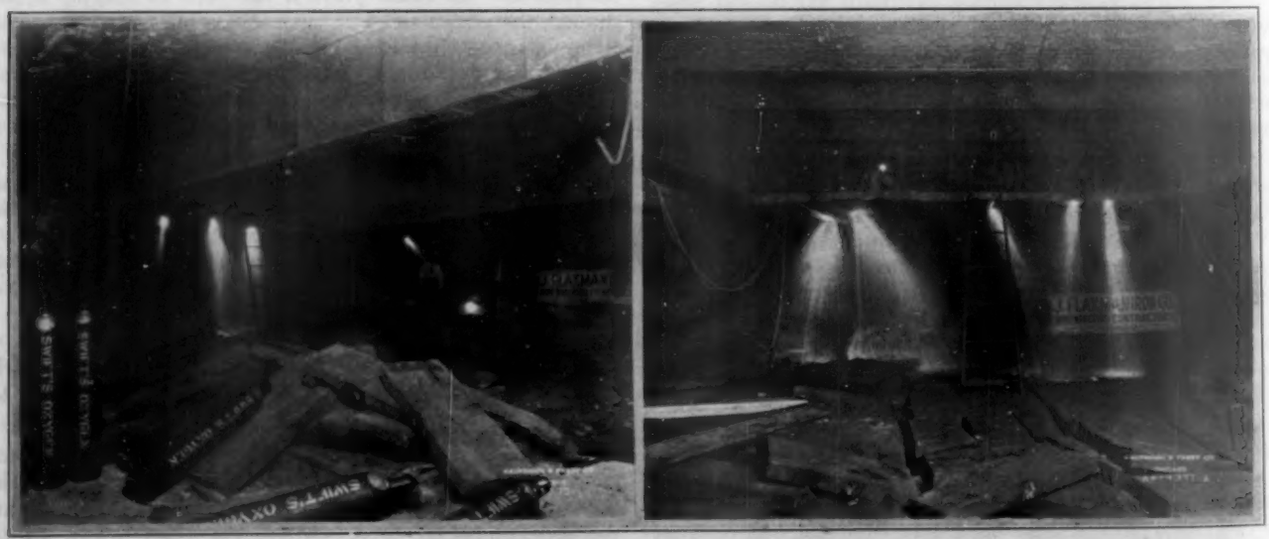
The J. Flaxman Iron Co., were only able to secure this contract by guaranteeing to cut up the vault and remove all the steel from the premises within a thirty day period. Their contract carried a clause which called for the payment of $100.00 a day to the bank for every day they were on the job and after their thirty day period had expired.

One of the competitors bidding for the job guaranteed to do the work in sixty days but this was not soon eough, so the contract fell to Mr. Flaxman. His ingenuity enabled his men to complete the entire work to the satisfaction of the bank officials within the extremely short time of only seventeen days which was thirteen days under his agreement.

When the men first started the work the plan was to cut large sections from the ceiling and the vault. These large sections were to be dropped to the floor of the vault and there cut up into suitable sizes for carrying away. The size of the first few slabs were about four times as large as those used later in other work that were about four feet by twelve feet in size, and when they dropped to the floor of the vault their great weight caused vibrations throughout the entire building. This practice had to be discontinued and it was necessary for the cutters to reduce the size of the pieces to a foot and a half in width and four and one-half feet in length.

The thickness of the walls was four inches and the first man on the job tried to use the pressure of about fifty pounds. With this average of pressure he was unable to pierce the wall and the pressure was then increased to sixty pounds. Still this was not enough. Eighty pounds pressure was then tried. With eighty pounds pressure the metal was just barely pierced but by no means cut enough to allow the large pieces to fall to the floor, and so the pressure had then again been increased to 100 pounds. 100 pounds pressure would have worked but not as well or as quickly as 120 pounds, so that was the pressure which Mr. Flaxman told his men to use, for with it a good, wide clean cut was made and the pieces dropped as soon as the last bit of metal was cut.

In the foreground, one can see several large slabs with holes burned in the edges about in the middle. This was done so that a special rigging could be attached to the slabs in order to remove them from the building. Instead of attempting to use two wheeled trucks and men to move the slabs and load them on the trucks Mr. Flaxman ran a steel runway into the room, and on



Oxy-Acetylene Cutting Torches Remove Vault in Record Time.

this he rigged up a small hoist and in this way quickly removed the slabs and loaded them on the trucks. He attributes the great speed with which they finished up the work, to the use of this method of removing the wall section. It would have been very difficult to use two wheeled trucks and men for this work as the pieces varied in weight from eight hundred to twelve hundred pounds.

The doors of the vault were not scrapped. The wall adjoining was cut within six inches of the door and the doors were then lowered to the next floor to be used again. At first it was thought by the bank officials and the architect that the heat of cutting would warp the door being used if cutting was done any closer than two feet to the edge of the door.

The first cut was done in accordance with their wishes but when they went to lower the doors through the hole in the floor they found the opening was not large enough and it was not practical to make it any larger. Therefore, they decided to make Mr. Flaxman go ahead with his original idea and cut down the remaining part of the wall as close as six inches to the door. This was done very satisfactory as the doors did not warp in the least. From the illustrations you can also see how difficult the working conditions were, for the space above the roof was so small that the men were forced to work in a crouching position at all times. In another space the vault went right up to one of the walls of the building.

The high oxygen pressure necessitated the use of a great deal of oxygen and 850 tanks were used on this job together with 96 tanks of acetylene. During the entire seventeen day period five men were kept busily at work all day long and three other men working right through on the night shift. The apparatus used on this job were the K-G torches made by the K-G Cutting and Welding Company. A number four tip was used in this work, and the gases used were Commercial Acetylene and Swift Oxygen.

THEORY OF EFFECT OF SURFACE MATERIALS ON STEEL ELECTRODES

(*Continued from Page 27*)

than the long arc. It is reasonable to suppose that the electrical resistance of a short arc vapor stream is less than that of a long one.

Conclusions

Welders have been appreciating more and more that there are good and bad welding rods, but there has not been much information available as to what makes a rod good or bad. The surface materials certainly seem to be one very important factor governing the quality of both gas and electric filler rod. For gas rod, a clean, metallic surface seems essential, while for metallic arc welding, the presence of non-metallic materials on the surface is required. Surface materials constitute the real difference between gas and electric filler rod.

(NOTE—This is one of a series of articles by Mr. Green in which the welding qualities of electric and gas welding rods will be discussed. The observations made and conclusions drawn are the result of a long series of experiments but it is recognised that other investigators may have formed different conclusions as a result of experiments made in other ways. Correspondence is therefore invited on the subjects covered, in order that any errors made in conclusions may be corrected and any data which serves to confirm the conclusions given will also be welomed. It is felt that much good will result from a thorough discussion of the different characteristics of welding rods and wire.—Editor.)

WELDING IN THE JUNGLES

By George Cain

This is not intended to claim to have performed a super task in doing this job, by way of magnitude, or by extraordniary skill or judgment, but perhaps to show that when one is "up against it" what can be done, as this job was done under what we would now call "Pre-Historic" conditions.

Many readers will no doubt (as I myself do now) consider this quite an ordinary job, but to undertake it under the conditions which I did puts quite a different aspect on it.

A few years ago I accepted a position as an oxy-acetylene welder in the Fiji Islands which is about 3½ days sail North from New Zealand. An experienced welder was required. At that time I had had only 3 months experience in a job welding shop where plenty of welding was being done, but I actually had very little handling of the torch. However, I considered I was the man for the job.

After I had been there, at my new job a couple of days, getting accustomed to the climate and mosquitos my employer informed me that there was a "nice little oxy-welding job" for me at one of the boats.

The job was a cast iron flywheel of an oil engine off a 250 ton schooner. The wheel was about 6 ft. in diameter, and was about one ton or more in weight. A piece was broken out of the hub of the wheel for about ⅓ of the way round taking the keyway with it. Parts of two of the spokes had also gone with the piece. The hub was about 12 inches in diameter and about 15 inches in depth, and fitted on about a 6-inch crankshaft. The break was caused no doubt through the heavy sets. The actual amount of welding done was about 15 inches long and about 3 inches thick. Of course the job required pre-heating as part of the spokes had gone, but how was the pre-heating to be done? The boss said there was plenty of charcoal available. For my part at that time I had not heard of charcoal for pre-heating jobs. We were used to city gas for that purpose, so I was in doubt about whether I was going to get the job pre-heated satisfactorily, but there was not the slightest doubt about the success of it. This was the most up-to-date part about it.

As for equipment, etc., we had an old leaky low pressure non automatic acetylene lighting generator without a hydraulic safety valve, but that did not matter because none of us knew any better. As for my experience, I had not seen and did not know anything about the low pressure system of welding. The bit of experience that I had had was with the high pressure system, but we kept the generator a fair distance from the work, and had an Indian attending to it so the risk was not so great.

I had to borrow a large torch from a neighboring village to do the job, and was very fortunate to get one large enough. My boss had a torch with *one* size tip (medium) to do all jobs.

There were no welding rods and no flux, and to get anything from New Zealand or Australia meant to wait about three weeks for the next boat.

There happened to be a number of stove or range tops about, which are generally about 3/16 inch thick so I decided to cut these up into strips for welding rods and after a couple of days drilling and chiselling we had enough strips about ¾ inches in width to do the job. Then for the flux. The boss remembered that he had a small engineer's text book which contained a small article about welding; from which we managed to find a formula for cast iron flux. Equal quantities of Carbonate of Soda and Bi-carbonate of Soda. This we managed to get from the local Chemist, luckily.

There was no one else in the district that had had any experience with welding so I could not get any assistance that way but I had lots of confidence, nothing to lose, and a reputation to gain, for I knew that if I could not make a success of the job there was no one else there who could.

Well, the job was pre-heated satisfactorily but with our temporary furnace the wheel could not be welded lying down so it had to be lifted out of the fire. We stood it up and turned it around during the welding. It took about 4½ hours to do the welding, on and off, because with a ton of red hot metal only partly covered, as the asbestos was not too plentiful and in a tropical climate I could not stand up to the job more than about a ¼ of an hour at a time and then have a spell, until after the

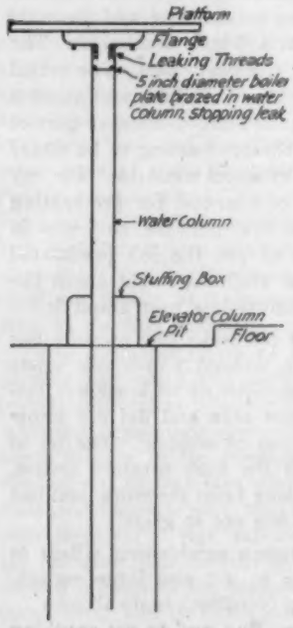
first couple of hours when the job was cooling. I was then able to "stick to it." I might state that masks, asbestos gloves or suits, were not available and I was kept wrapped in wet towels for most of the time. After the welding was finished the job was again heated as usual and allowed time to cool and put back into service.

A year afterwards I heard the job was still going strong, but whether it is still going today I cannot say. For I am "foo th noo" with tropical life. The tropical South Sea Islands may have their romances and their charm but an oxy-welder's job is not one of them.

WELDING A COAL ELEVATOR

By W. F. Beach

A short time ago I was called to the local gas plant to weld a coal elevator. They were in great distress, because it was leaking water badly at the point where the main pipe which raises the platform screws into the cast iron flange. The threads had become so badly worn that they could not be tightened.



Welding on Coal Elevator

It was necessary to block up the platform from the floor and then unscrew the cast iron flange, which was 24 inches in diameter, from the water column, which was five inches in diameter and one-half inch in thickness. The threads were on the inside of the column, and extended to a depth of 3 inches.

The water was syphoned from the column to a depth of about 3 feet, then a portable grinder was used to grind the inside of the column until the metal was bright. Next a piece of boiler plate 5 inches in diameter was brazed inside the column just below the threads. This made a water-tight job, because the boiler plate took the pressure of raising the elevator and stopped the water from coming out around the loose threads on the flange. The next thing was to heat the column to a cherry red for a depth of 2 inches from the top. Then the flange was replaced, and when the column was cold it was shrunk tightly to the flange. The entire job took about two hours, including stripping and assembling, saving the company about $300.00, for the cost of the welding job was only $15.00.

CLEVELAND A. W. S. ELECTS OFFICERS

Cleveland Section—American Welding Society elected the following officers for 1926-27 at a recent meeting:

Chairman—Professor Herbert M. Boylston, Case School of Applied Science; Vice-Chairman—R. B. Fehr, Una Welding & Bonding Co.; Treasurer—G. B. Close, Ohio Chemical Co.; Secretary—R. K. Randall, Cleveland School of Technology; Program Committee—J. C. Lincoln, Chairman; John H. Thornton—H. G. Dyar—R. B. Fehr; Membership Committee—O. J. Bornemann, Chairman; A. F. Davis—O. J. Bornemann—K. Haas—R. J. Hurt—J. E. Wolcott, Jr.

UNDERWRITERS' LABORATORIES APPROVE MEDIUM PRESSURE PORTABLE ACETYLENE GENERATOR

What is said to be the first medium pressure portable acetylene generator to be approved by the Underwriters' Laboratories has just been announced by the Bastian-Blessing Company, Chicago. This generator is known as the Rego "Pa." Before passing their approval upon this generator it was subject to some rather unusual and severe tests. These are shown in the accompanying illustrations.

Illustration No. 1 and No. 2 show the stability tests which were made. No. 1 shows how far the fully charged generator can be tipped to one side before becoming overbalanced, while No. 2 shows the same test being made to the rear.

No. 3 shows the fully charged generator tipped over on its side with the carbide feed locked. It is said that practically no gas at all was generated during this test and after being returned to an upright position the generator was hooked up to the pipe line and the entire supply of carbide was run through as in an ordinary operation. A more severe test was made with the generator containing generated gas at a pressure of 10 pounds and with the feed valve and lock open. Upon being tipped over, the pressure rose to 15 pounds, the blow-off valves opened, and the entire charge of gas and water was expelled through the blow-off valve without creating a dangerous pressure.

In No. 4 the generator was attached to an automobile and pulled over rough, sandy ground. During this test the rope holding the generator to the automobile was broken four times while jerking the generator out of some deep holes. The generator was not damaged in this test.

Rigorous Tests Applied to Portable Acetylene Generator.

Repairing Oil Saturated Crankcases

Aluminum Castings Which Have Absorbed Oil in Service Require Careful Treatment to Remove It Before Welding

By M. Desgranges in Revue de La Soudure Autogene
Translated By Capt. D. Richardson

THE extensive increase in the number of automobiles on the road is responsible, to a certain extent, for the development of a distinct class of welders whose qualifications are necessarily of a wide variety.

It is very rare, when an automobile is sent to a garage for overhaul, repairs or reconstruction, that oxy-acetylene welding is not used in some way or other, it may be for filling up a hole, reinforcing or building up worn surfaces and, frequently, for welding broken or cracked parts. Such work ranks with brazing, turning, fitting and other workshop operations the automobile engineer has to be familiar with. On the other hand if the welding operations cover repairs to Cylinder blocks, crank cases, gear boxes, etc., the garage proprietor will frequently hand over the work to a job welder specializing in general repair work.

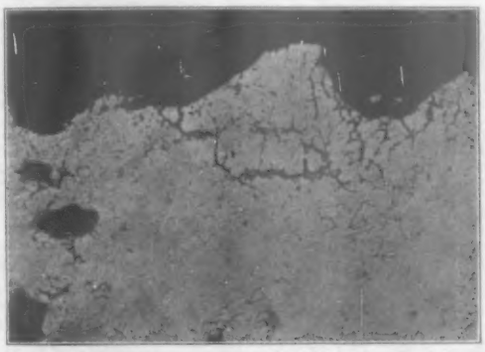


Fig. 1

The latter, and we are not including here the important firms who employ a large number of workmen each of whom are experts in some particular branch of welding repairs, should possess a very complete knowledge of the subject, but, unfortunately for the development of welding processes this is not always the case.

Amongst the numerous variety of repairs that vary in difficulty are crank cases made from the light alloys of aluminum. In certain cases, the success of the welding operation is sure whilst in others the welder is up against a whole series of difficulties which are the result of the position of the fractures or cracks or to the state of the metal, or more exactly, the alloy.

The repair of a crank case or gear box does not fall into the class of repairs to worn parts. Generally the break is brought about by the failure of details such as the connecting rods, crank shaft, pinion and fork of the gear box. Constant vibration and innumerable shocks to which an automobile is at all times subject may be the cause of failure. Too often the welder is ignorant of the past history of the car and the results of long usage. He is also ignorant as to what kind of alloy he is dealing with, i. e., aluminum-copper, or aluminum-zinc, to say nothing of other elements present in the alloy.

The light alloys of aluminum, in common with all metals and alloys that are used without being submitted to mechanical treatment such as rolling or forging, contain numerous blowholes more or less large and more or less numerous. In use, the crank case oil reaches a certain temperature, along with the metal, and penetrates readily the porous metal and consequently is found throughout the alloy owing to innumerable small cracks which are found between the joints of the crystals. These cracks act as canals or feeders and connect up so as to form practically small chambers for oil.

From the mechanical point of view, these small defects are not serious, because the metal of crank cases is always comparatively thick in view of the stresses it has to resist. From the welding point of view it is a serious matter. Consider two crank cases exactly similar, the one after long usage and the other absolutely new; the repair of the latter is extremely easy and forms the daily routine work of foundries casting the light alloys of aluminum. The repair of the former is often one of considerable difficulty, because here one is dealing with a metal more or less impregnated with oil.

Fig. 1. shows a microphotograph of a portion of a crank case close to the surface. On the left of the figure large blowholes are seen, and these are present in all castings, but more important perhaps is the network of fine cracks near the upper surface and which form channels for the infiltration of the oil in the metal. Fig. 2 represents an enlarged photograph of another portion of a crank case which is equally riddled with cracks. It is obvious the welder is not able to see with the naked eye these numerous minute cracks, and to realize that in the body of the metal itself there is a more or less quantity of oil according to the condition and age of

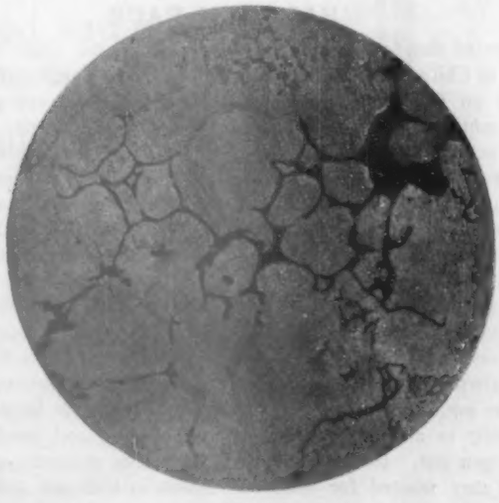


Fig. 2

the crank case. But, during the welding operation there is no difficulty in becoming aware of its presence owing to the formation of black patches in the middle of the molten metal which makes it very difficult to obtain a good joint.

It is therefore important to take all the necessary preliminary precautions and determine the condition of a crankcase before attempting to repair it. What are these precautions? In the first place it is essential to ensure that a minimum amount of oil is in the neighborhood of the portions that have to be melted, hence the best thing is to remove

portions that are likely to contain appreciable amounts of oil, which means, of course, portions near the fractures, which are more or less in the form of the network described. In other words, it is advisable to bevel on a larger scale than usual after having carefully cleaned the entire casting and more particularly the edges of the brakes. This cleaning can be done with petrol or, as is usual, by dipping the casting in a bath of caustic potash or caustic soda followed by washing in hot clean water.

These indespensable precautions are not an infallible remedy for removing oil from crank case, etc. In many cases it will be found that during the welding operation black patches still form, due to oil flowing from the pores of the casting. The welder should provide himself with a wire rod flattened and curved at its end so as to be in a position to remove these impurities from the molten metal and edges as they form. Immediately after using this tool it is advisable to add a fresh supply of flux to the molten bath.

In the case of crank cases heavily saturated with oil, it is almost impossible for the welder to obtain satisfactory results even with these precautions. The following method will in such cases give satisfactory results; the edges of the weld should be heated just up to the melting point followed by the addition of flux and the removal of the patches of oil which form on the edges. After allowing the heated portions to cool the edges should be thoroughly cleaned with a scratch brush and water so as to entirely remove the black crust of oil which covers the faces of the bevel. After this treatment it will be found that casting can be welded in the usual way with considerable less difficulty.

The question of preheating, method of welding, power of blowpipe, welding rod, etc., are not within the scope of this article which is only intended to explain to job welders the reasons why some welds on aluminum which are saturated with oil are unsatisfactory, and to avoid failures from this cause.

CHICAGO FIRMS SUPPLY GAS FOR ELKS BALLOON RACE

One of the features of the convention of the Elks, which was held in Chicago this month, was a ballon race starting from Grant Park on Chicago's lake front. Four balloons were entered in this contest, and as each one has a capacity of 35,000 cubic feet, and actually used 40,000 cubic feet of hydrogen, it is easy to guess that the supply of hydrogen in the city was severely taxed on the day the balloon race started. It is reported that the gas was supplied by Swift & Company of Chicago and by the Carbo-Hydrogen Company plant in the Chicago district, a total of 800 tanks being used.

While preparations were being made for the race the starting ground was naturally cluttered up with newspaper reporters. At least one of them became interested in the subject of hydrogen gas and attempted to write the results of his investigations for one of the evening editions. His report was evidently intended to be amusing to anyone familiar with the nature and production of hydrogen gas. It certainly was. The Elks evidently got everything they wanted for their convention in Chicago, and Chicago gas producers saw to it that they got gas when they needed it. In fact, they were prepared to supply twice as much if it had been necessary.

CURRENT WELDING LITERATURE

AUXILIARY WELDING RESISTORS—Four page bulletin recently issued by the General Electric Company, Schenectady describing the Type AW resistors for use with constant potential generators for metallic welding. These reduce the potential from 60 volts to a range of from 20 to 30 volts, by inserting a resistance in series with the arc in each welding circuit, to absorb the excess voltage.

ARC WELDED PRESSURE TANKS SAFE, by S. W. Miller—A letter pointing out two fallacies in a recent article criticizing the use of welding for tanks. The writer points out that there is usually a lack of information back of the criticisms which are made of the welding process-Power June 29th.

OXY-ACETYLENE TIPS—Monthly publication of Linde Air Products Company. June issue contains the following articles: Modern Hand-Worked Iron; Testing a Large Oxwelded Kiln; Steam and Water Piping for Residences; Imagination-And a Welding Blowpipe; Cheaper to Fix It Than to Write; Selection and Care of Hose; Work to the Machine—Or Machine to the work; Ox-welding Aids Sugar Refining.

SMITH-O-GRAMS—Monthly publication of Smith Welding Equipment Corporation. The June issue contains an article describing the procedure for welding monel metal and discussion of the torch as a production tool and descriptions of new items in the line manufactured by the publishers.

THE WELDING REVIEW—Publication of the Canadian Liquid Air Company, Montreal. The May issue carries articles on bronze welding of cast iron, manufacturing of trucks by oxy-acetylene welding and a list of the uses of the oxy-acetylene torch in making automobile repairs.

ELECTRIC WELDED CONSTRUCTION, by James Caldwell—Discussion of paper read before the Institution of Welding Engineers—The Welding Journal, London, June.

WELDING FACTS AND FIGURES—A chapter from a handbook for welding engineers being prepared by D. Richardson and E. W. Birch. This chapter discusses elements, compounds and mixtures, chemical symbols, automatic weights and chemical equasions.—Welding Journal, London, June.

THE WELDING OF STEEL CONSTRUCTION, by C. F. Keel—Welded joints can be as safe as riveted structures. Maximum strength is secured by proper design. The author gives several illustrations of proper design of welded steel structures—The Welding Journal, London, June.

WELDING EQUIPMENT AND AIR TOOLS DECREASE LOCOMOTIVE REPAIR COSTS, by Frank W. Curtis—Reconditioning and reclaiming flues—Air operated device for expanding flues—Counterboring wheels—Cleaning water heaters—Air operated clamps—American Machinist, July 8th.

WELDING AND CUTTING SPARKS—Monthly publication of the Kentucky Oxygen Company. A complete file of this house organ has been received and it contains a wealth of material of interest to oxy-acetylene welders. In each issue will be found several articles on different types of welding problems as well as interesting descriptions of new products which the company has for sale.

STUNTS WITH THE WELDING TORCH, by L. A. Cowles—Case hardening, drilling in concrete, building up worn parts, patching tanks, repairing boiler tubes—Power, July 6th.

ARE WELDED PRESSURE VESSELS SAFE?, by E. E. Thum—Welded pressure vessels are safe when made under correct pressure control. The elements of this control are correct design of the article, the use of proper materials for the work, intelligent checking in the skill of the operator, providing necessary tools and appliances, providing adequate supervision, and making careful tests of the completed article—Power, June 8th.

WELDING HIGH CARBON TOOL STEEL AND HIGH SPEED STEEL WITH THE OXY-ACETYLENE TORCH, by George L. Walker—The Metallurgy of high carbon and high speed steels, the selection of welding rod, the precautions to be observed by the welder when handling these alloy steels, instructions for handling certain specific jobs—Acetylene Journal, July.

SHOP PRACTICE IN WELDING, by G. O. Carter—A discussion of recognized practice in preparing the joint, the jigs and fixtures most commonly used, and the methods for accomplishing the weld—Acetylene Journal, July.

WELDING COPPER BY THE OXY-ACETYLENE PROCESS, by A. Eyles—Fundamental points involved in making welds in copper and description and illustration of design in procedure for making various types of joints—Acetylene Journal, July.

ACETYLENE—A description of acetylene gas from the welder's standpoint. General rules for handling acetylene cylinders, how to determine the volume of acetylene in a cylinder, precautions regarding acetylene generators—Acetylene Journal, July.

OXY-ACETYLENE TIPS—Monthly publication of the Linde Air Products Company. The July issue contains the following articles:

Oxwelding and Cutting in the Coal Mining Industry.
Special Equipment of Non-Ferrous Metals.
Oxwelding Contributes Its Art.
Featuring Pipe Specials.
A Bright Idea.
Pipe Supports of Welded Pipe.
How Cast Iron Kettles Are Repaired.
Keep Cylinder Record.
Primary Exercises in Sheet Metal Welding.
A Cutting Kink for Contractors.
Welding Accessories.

POINTERS ON PIPE WELDING, by M. C. Cockshott—Procedure for several types of pipe welding jobs and comparative tests of brazed and lap welded joints—Power, June 15th.

THE WELDING REVIEW—Monthly publication of the Canadian Liquid Air Company, Montreal. The June issue contains an article on welded pipe railings, some hints for welders, uses of the torch for automobile repair work, suggestions for keeping apparatus in condition and photographs of welding on metal iron work and pipe line work.

FUSION WELDED PRESSURE VESSELS, by S. W. Miller—Suggestions for changes in the present code of A. S. M. E. and specifications for a 60 inch welded tank, 20 feet long, for a working pressure of 200 pounds—The Boiler Maker, June.

JOURNAL OF THE AMERICAN WELDING SOCIETY—June issue contains articles on the following subjects:—Autogeneously and Electrically Welded Boilers and Containers; Discussion Technical Papers Presented at Annual Meeting; Discussion Resistance of Shells and Tubes to Internal Pressures; Discussion on Calculation of Stresses in Pipes; Oxy-Acetylene Welding of Sheet Aluminum; X-Ray Tests of Welds.

CERTIFICATES FOR WELDERS, by P. Hollard—A discussion of the problems involved when it is attempted to issue permits to welding operators certifying their ability to do satisfactory work—Revue de la Soudure Autogene, Paris, May.

IS A BEADED WELD NECESSARY—Some welders have objections to making their welds penetrate enough to cast a formation of beads on the reverse side of the weld but in the author's opinion a weld which lacks this evidence of complete penetration is very apt to have weak spots in it.—Revue de la Soudure Autogene, Paris, May.

TACKING SHEETS BEFORE WELDING—Differences of opinion regarding this subject are due to the fact that welding is applied to so many varieties of work. The advisability of tacking and the amount of tacking to be done is shown to depend upon the thickness of the metal and the diameter of the pieces to be welded.

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For Sale—Gas compressor, four stage, 3000 lbs. working pressure, A-1 condition. Address Box 502, Coraopolis, Pa.

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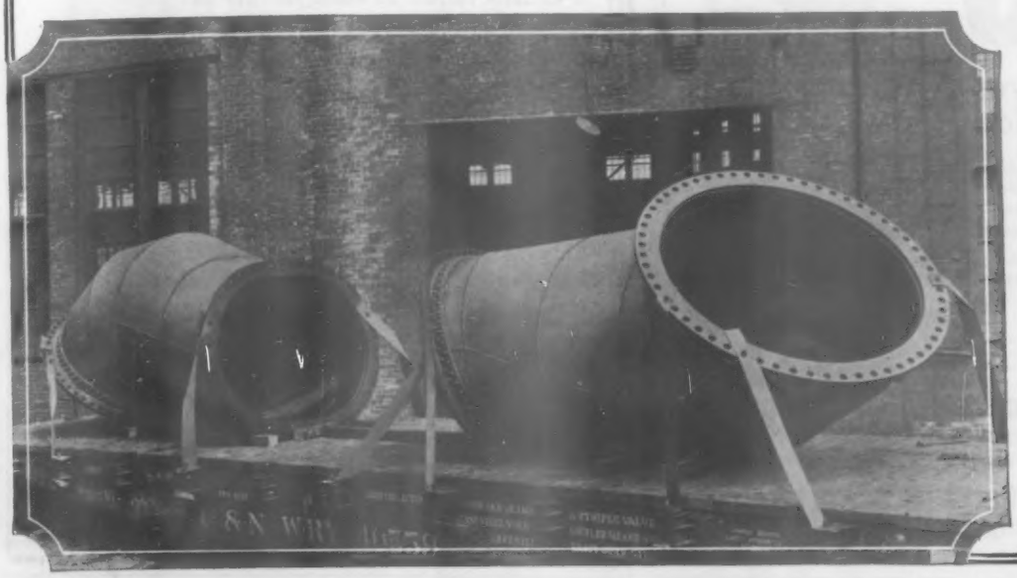

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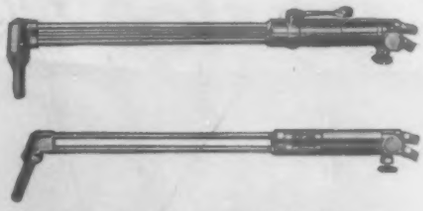

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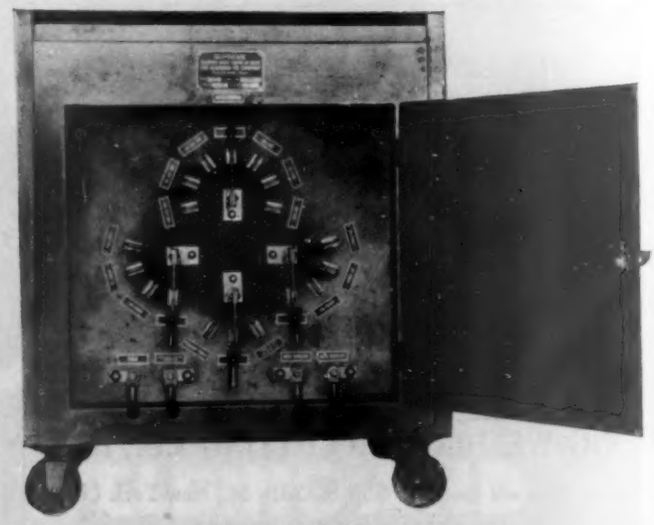

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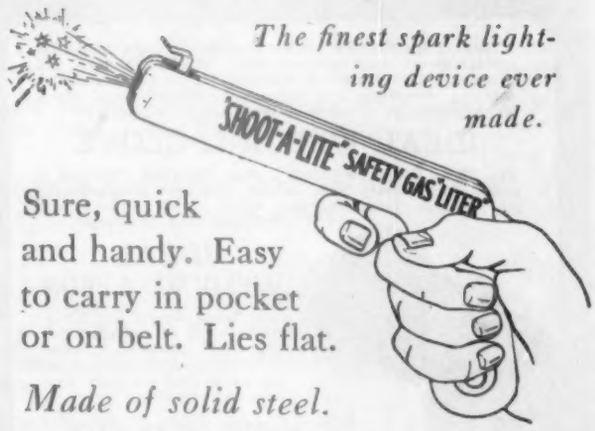

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Dixon's Graphite Rods and Plates for Welding

Made in all diameters, lengths and sizes.

Small diameter rods are sold in 4, 6 and 8 inch lengths, the shorter the rod the less breakage in shipping.

Also Dixon's Graphite Welding Putty. In 5 and 10 lb. cans.

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INDUSTRIAL GASES

OXYGEN — HYDROGEN
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Cylinders—Valves—Regulators
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Welding Wire—Fluxes
Cast-iron and Aluminum Rods
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All equipment fully guaranteed
Quick shipment and low prices

KNOWLES ELECTROLYTIC PLANTS for the production of hydrogen

Knowles Patented Cells are safe, simple, easy to install, automatic, low in first cost and maintenance, and in addition to flexibility of operation have the advantage of producing also a quantity of pure oxygen equal to 50 per cent of the hydrogen volume. Can be furnished in any size up to 15,000 amperes. Total annual hydrogen capacity of plants now in operation, over one and one-half billion cubic feet.

Our experience as American Manufacturers and Distributors enables us to recommend these plants unqualifiedly.

Write for literature and quotation

International Oxygen Company
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Main Offices: Newark, N. J.
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IDEAL FACE SHIELDS

Ideal Face Shields protect the head, chest and neck against direct and reflected rays. Easily adjusted and removed. Constructed of vulcanized fibre and aluminum, assuring durability and lightness. Hinged door allows quick inspection of work or interchange of glasses.

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The Ideal Glove for Electric and Acetylene Welders is made from Sheep Skin, which has been Subjected to an Asbestos Treatment and which makes it both heat resisting and fireproof.

IDEAL WELDING APRON

The Ideal Apron for Welders is made of leather which has been especially treated to stand the heat, and at the same time be very flexible and durable.

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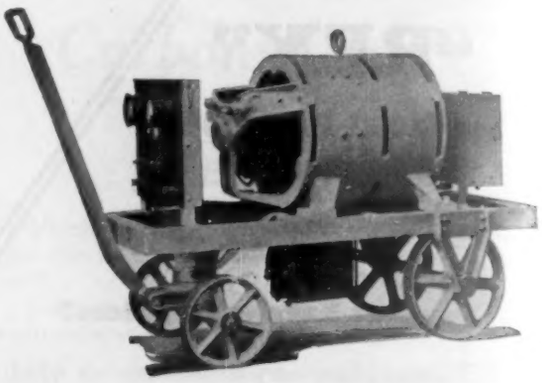

Burke Arc Welder

Holds a steady, short arc and positive adjustment to an infinite number of current values.

Current regulation is easy—just turn the hand wheel to set the indicator for the desired current.

From 50 to 300 amperes instantly available.

Send for Bulletin 133

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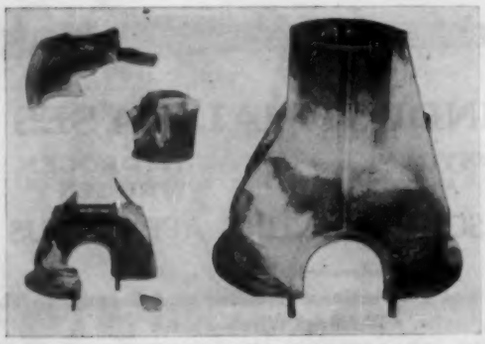

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"New Process" Aluminum Fix

Makes Broken or Cracked Aluminum Parts as Good as New!

IN MANY cases automobile work can be done without dismantling. Preheating is not necessary. Aluminum Fix is better and quicker than acetylene welding and there is no warping of the metal. It will work on the thinnest or the thickest of sheet or cast aluminum. Oil has no effect upon it. Aluminum Fix can be applied with a gasoline torch, lead burner, gas or acetylene torch. It has a melting point of 385° and has stood a Government test of over 10,000 lbs. per sq. in.
Our "NEW PROCESS" Welding School will teach you how to use it FREE!

Manufacturers of Aluminum and Iron Fix

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1964 East 55th Street, Cleveland, Ohio, U. S. A.

Safety Goggles for Welders

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STRAUSS & BUEGELEISEN
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Welding Rod

3000
WORKING WELDERS
are kept busy full time
melting the daily output of

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Manufactured by
CHICAGO STEEL & WIRE CO.
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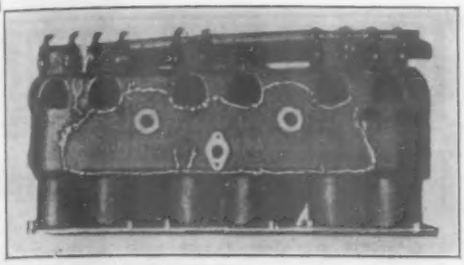

Block Welding—No Pre-Heating

Just clamped together and welded in **25 minutes. Total cost 60c** for labor, material and electric current! No cutting out—**no preheating.** Block was cracked around bottom edge, up sides, and around spark plugs; only part holding was 1½ inches between plugs 5 and 6. This job gave perfect satisfaction and the engine is still in use.

Seneca Electric Arc Welders

Electric Welders are always ready to go—never "out of gas!" To this advantage the Seneca adds low first cost, low operating cost, minimum up-keep, simplicity and ease of operation.

Seneca welders are successfully used by job welding shops, railroad shops, iron and steel foundries, manufacturing plants and scores of others. An extremely wide range of capacity makes this possible.

Let us give you our sales plan and data on the many money-making uses of the Seneca Electric Arc Welder.

Seneca Electric Arc Welder Co.
Seneca, Kansas

You Can Do It Better With TORCHWELD

You have heard it said—*"It will work just as good as Torchweld"*

Even though that claim does not prove to be true there must be some very good reason why Torchweld Gas Welding and Cutting Equipment is so often used as the "Standard of Comparison."

***The real reason is*—"Only Torchweld makes Gas Welding and Cutting Equipment the Torchweld Way!"**

Send for Catalog No. 23-E

Torchweld Non-Flash Welding Torches are made in eight sizes to meet every production or operating requirement.

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Electric Arc Welding Equipment

Transformer Arc Welders (A. C.)
Motor Generator Sets (Direct Current)
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A complete line of Electric Welding Accessories always carried on hand.
Electrodes—Holders—Masks—Handshields—Glasses—Cables, etc., etc.

ALLAN MANUFACTURING & WELDING CO., INC.
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If you dig into facts you will find

lives up to its slogan *"More Gas per Pound"—*

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Our welding carbon products are designed especially for welding operations

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OXY-ACETYLENE PROCESS

QUALITY

New Mixing Principle

a regulator that accurately controls gases, the greatest working range ever covered by ONE torch—are exclusive IMPERIAL features.

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for the Production of
OXYGEN—NITROGEN

Furnished In Any Capacity from 70 Cubic Feet Per Hour Upwards.

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Manufacturer of:
A. C. & D. C. Welding Sets
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"ANTI-BORAX"
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are made for every metal and have EXCEPTIONAL merit.

BRAZ-CAST FLUX
For bronze welding of Cast Iron.

We also make the popular "E-Z" Welding Compound for forge welding.
Samples of any upon request.

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ACETYLENE WELDING SHIELDS
Our No. 11 Shield, especially for welders who wear correction glasses. You will enjoy the comfort and freedom afforded by it.

This shield is fitted with "ESSENTIALITE" Welding Glass—The glass you will like. Price, $4.00 each, f.o.b. Chicago, Ill.
Sold by all dealers in welding materials, and manufactured by:
CHICAGO EYE SHIELD COMPANY
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DRILL—GRIND—POLISH
STRAND
FLEXIBLE SHAFT EQUIPMENTS
Several Sizes
N. A. STRAND & CO.
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WELDBAK

WELDBAK is a white, non-burning **molding powder**; is economical, useful and for some work invaluable to the job welder. Stands the heat of the welding torch; quickly and easily molded; no shrinkage or warping. (Pat'd May 25, 1926. Other Pats. Pending.)

PRICE—10 LBS.—$3.00
Write
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WELDING ROD HOLDERS
For the Oxy Acetylene Welder.
Price $1.00

ALL STEEL WIRE BRUSHES
45c Each, 3 for $1.00

Write for Dealers' Prices
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REBUILT ELECTRIC WELDERS

We buy, sell, exchange, rent and repair:
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Take advantage of our specialized welding service.
GOODMAN ELECTRIC MACHINERY CO., 126 Green St., Newark, N. J.

FACTS TALK No. 4

Automatic Spot Welder welding Reed Concrete Clips

FACTORY of ALBERT OLIVER and SON, Inc., 717 East 140th Street, New York, manufacturing the Reed Concrete Clip widely used in fireproof building construction as an improved form of reinforcing to bond the concrete to the steel members. Perfect welding—an essential in beam clips—is a recognized feature of Reed Concrete Clips.

Fifteen to One

Another opportunity for comparing ELKONITE with hard drawn copper

Material Welded
Reed Concrete Clips, 12 gauge galvanized steel wire.

Voltage at tip of Electrode
⅞ v. to 1⅛ v.

Amperes—25,000.

Electrodes previously used
Hard Drawn Copper.

Service Rendered
15,000 welds (2 days) before dressing.

Electrodes Now Used
ELKONITE W 25

Reason—**225,000 welds** (30 days) before dressing is required.

IF YOUR PLANT is doing resistance welding operations similar to the above this record should speak for itself in terms of economy, time saving and operation gains. Write the Elkon Laboratories for more data on the superiority of Elkonite Electrodes for this type of welding.

ELKON WORKS, Inc.
Subsidiary of P. R. Mallory & Co. Inc.
Weehawken, N. J.

Exclusive licensees under General Electric Co. Patents dated May 26, 1925, and September 1, 1925. Other patents pending to Elkon Works, Inc.

ELKON

It brought new business to this shop!

Electric Arc Cutting and Welding Co.,
152-158 Jelliff Avenue,
Newark, N. J.

Gentlemen:—

Greenwood, Miss.
June 29, 1926.

The gas engine set has helped me get new business and enables me to keep a good welder in the shop to take care of the work on the two "Alternarcs" when I am out.

I shall have to have a good boiler welder in addition shortly to handle the work with this machine. That 110 volt A.C. is so nice on hot boiler jobs. You see, I carry a small electric fan along and set it where I get the benefit of the cooling breezes and I am never at a loss where to get a light to crawl into these dark holes.

I am expectantly awaiting the larger transformer so that I can use the continuous arc from the A.C. side of the generator, as the use of your "Alternarc" has certainly made me favor the peppy A.C. arc.

It looks as if I shall have to have another "Dualarc" set by next spring. I have promised to patch blisters and weld flues in five boilers and the ginners have only begun to overhaul gins. Crops look as though we will have another bumper crop, which means lots of repairs to gins.

I am going to have movies of myself operating the "Dualarc" set when I get my new building completed, and have them shown in all the outlying towns, for advertising purposes.

Your gas engine set is a dandy.

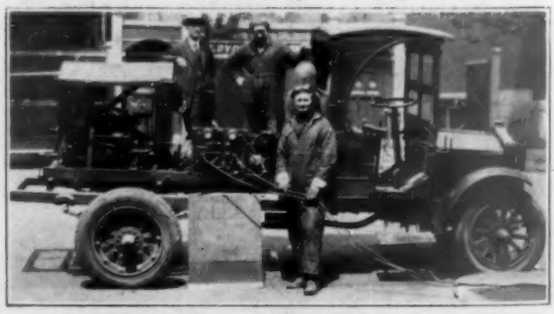
(Signed) W. D. BAUGH

Economy=Efficiency

With this unique DUALARC, economy truly equals efficiency. It is sound practice to have a portable DUALARC Welding Generator to take care of welding jobs away from the shop. It is also sound practice to have this portable DUALARC Welding Generator mounted on a frame which allows the release of the truck for other work. An idle truck means money lost. Especially is this true in a shop doing a lot of outside welding. Now DUALARC solves the problem by making one truck do the work of many.

The Dualarc Generator is driven by a gas engine with sufficient reserve power to operate an air compressor up to 10 H.P. if desired. Many gas engine sets just have engine capacity for the welding alone.

Electric Arc Cutting & Welding Co.
152-158 Jelliff Ave.,
NEWARK, N. J.
U. S. A.



A complete Dualarc Outfit Ready for Action.